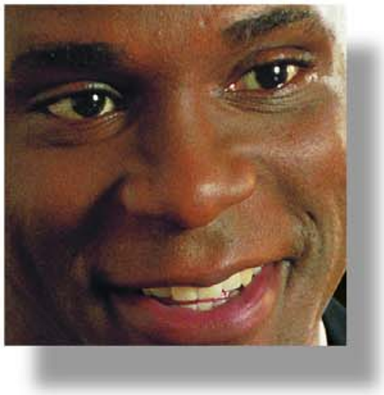
# CHAPTER 7

## Storage



Wedding bells are ringing. It is just two weeks until your big day! With all your wedding arrangements confirmed, the reception planned, and the honeymoon booked, you are happily humming the tune... "Going to the chapel and we're gonna get married."

Of the 247 invited family members and friends, 192 guests have responded, yes. Most of the regrets are guests who live too far away and cannot afford airfare and hotel expenses.

Even though you knew this would happen, it is disappointing that anyone must miss this special occasion. That is why you ordered digital photographs as part of your wedding package. At the end of your big day, the photographer will present you with a memory card containing at least 30 digital photographs of the wedding. You plan to post these photographs to your Internet hard drive before you leave for your Caribbean cruise.

For this very reason, your wedding invitations requested a reply with your guests' e-mail addresses. With the response cards in hand, you sit down at the computer and e-mail the Web address of your Internet hard drive to all those on your guest list. As you finish the first e-mail message, you hum, "Today's the day we'll say I do."

## OBJECTIVES

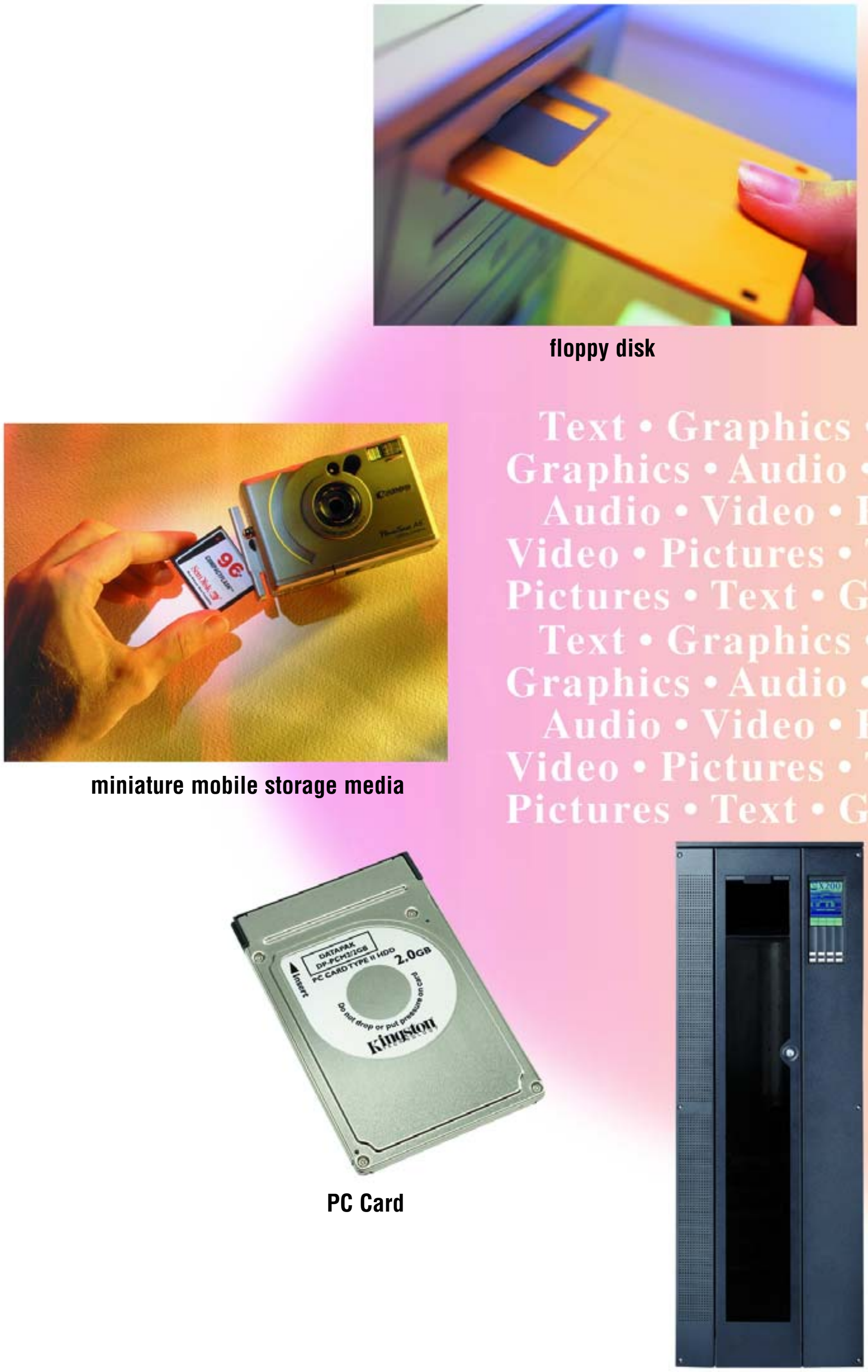
***After completing this chapter, you will be able to:***

- Differentiate between storage and memory
- Identify various types of storage media and storage devices
- Explain how a floppy disk stores data
- Identify the advantages of using high-capacity disks
- Describe how a hard disk organizes data
- Identify the advantages of using an Internet hard drive
- Explain how a compact disc stores data
- Understand how to care for a compact disc
- Differentiate between CD-ROMs, CD-RWs, and DVD-ROMs
- Identify the uses of tape
- Understand how an enterprise storage system works
- Explain how to use PC Cards and other miniature storage media
- Identify uses of microfilm and microfiche

## MEMORY VERSUS STORAGE

Storage refers to the media on which data, instructions, and information are kept, as well as the devices that record and retrieve these items (Figure 7-1). It is important you understand the difference between storage and memory, which was discussed in Chapter 4. The next section reviews the definition of memory and then discusses basic storage concepts.

**Figure 7-1** Data, instructions, and information are stored on a variety of storage media.



**floppy disk**

**miniature mobile storage media**

**PC Card**

**tape library**

### *Memory*

During processing, the processor places instructions to be executed and data needed by those instructions into memory. Memory is a temporary holding place for data and instructions. Sometimes called primary storage, memory consists of one or more chips on the motherboard or some other circuit board in the computer.

The two basic types of memory are volatile and nonvolatile. When the computer's power is turned off, **volatile memory** loses its contents. Almost all RAM is volatile.

**Nonvolatile memory**, by contrast, does not lose its contents when power is removed from the computer. For example, when a manufacturer permanently records data and instructions onto a nonvolatile ROM chip, the contents of the chip remain intact when you turn off the computer.

**hard disk**

**RAID**

**CD-ROM, DVD-ROM, or CD-RW**

Storage
Video • Pictures • Text • Graphics • Audio • Video
Text • Graphics • Audio • Video • Pictures • Text
Audio • Video • Pictures • Text • Graphics • Audio

**tape backup**

**CD-ROM jukeboxes**

## *Storage*

**Storage**, also called **secondary storage**, **auxiliary storage**, **permanent storage**, or **mass storage**, holds items such as data, instructions, and information for future use.

Think of storage as a filing cabinet that holds file folders, and memory as the top of your desk. When you want to work with a file, you remove it from the filing cabinet (storage) and place it on your desk (memory). When you are finished with the file, you remove it from your desk (memory) and return it to the filing cabinet (storage).

Storage is nonvolatile. Items in storage remain intact even when power is removed from the computer (Figure 7-2). A **storage medium** (media is the plural) is the physical material on which a computer keeps data, instructions, and information. Examples of storage media are floppy disks, hard disks, compact discs, and tape. A **storage device** is the computer hardware that records and retrieves items to and from a storage medium.

Storage devices serve as a source of input when they read and a source of output when they write. **Reading** is the process of transferring data, instructions, and information from a storage medium into memory. **Writing** is the process of transferring these items from memory to a storage medium.

The speed of a disk storage device is defined by its access time. **Access time** is the amount of time it takes the device to locate an item on a disk. The access time of storage devices is slow, compared with memory. Memory devices access items in billionths of a second (nanoseconds). Storage devices, by contrast, access items in thousandths of a second (milliseconds).

**Capacity** is the number of bytes (characters) a storage medium can hold. Figure 7-3 lists the terms

**AN ILLUSTRATION OF VOLATILITY**

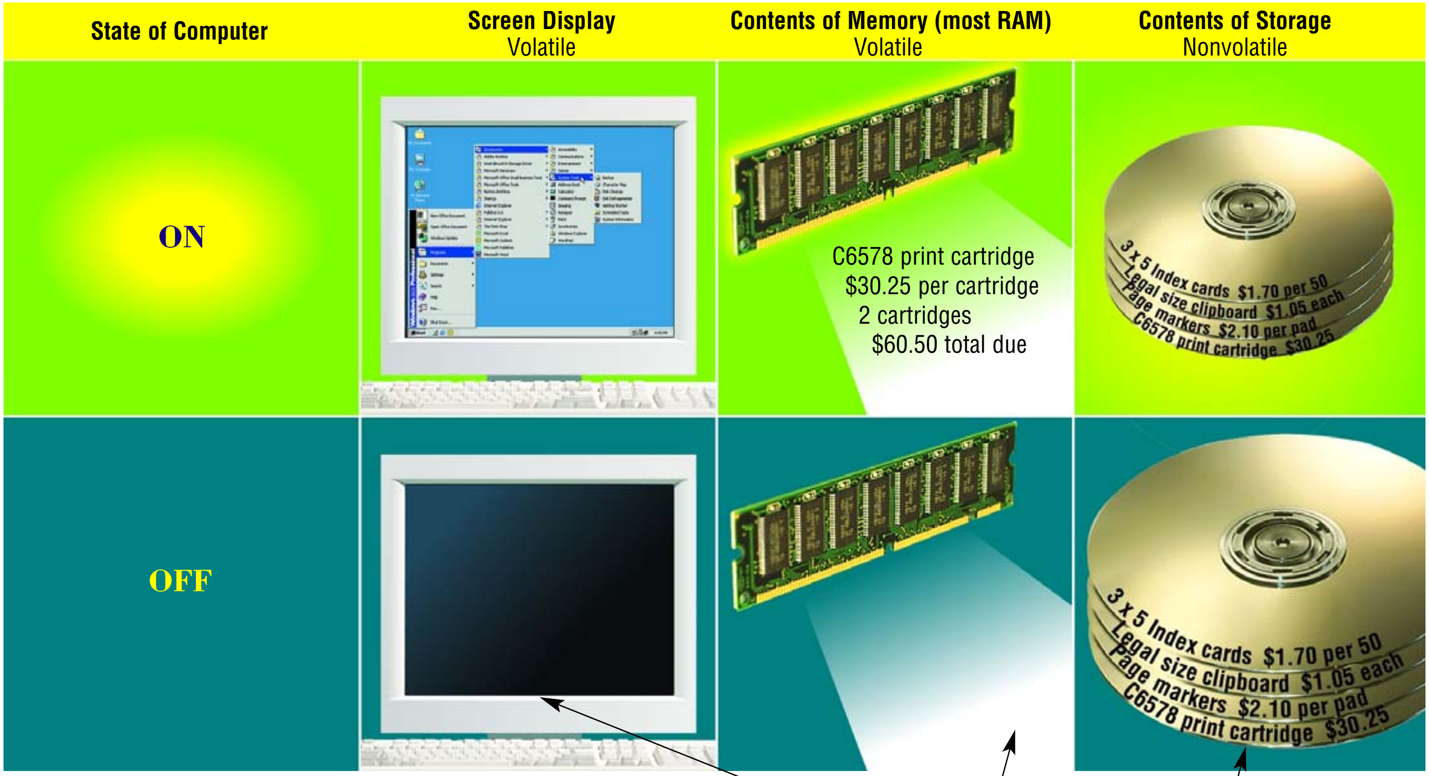

State of Computer
Screen Display
Volatile
Contents of Memory (most RAM)
Volatile
Contents of Storage
Nonvolatile
ON
C6578 print cartridge
$30.25 per cartridge
2 cartridges
$60.50 total due
3 x 5 Index cards $1.70 per 50
Legal size clipboard $1.05 each
Page markers $2.10 per pad
C6578 print cartridge $30.25
OFF
3 x 5 Index cards $1.70 per 50
Legal size clipboard $1.05 each
Page markers $2.10 per pad
C6578 print cartridge $30.25

**Figure 7-2** A screen display is considered volatile because its display disappears when power is removed. Likewise, most RAM chips are volatile. That is, their contents are erased when power is removed from the computer. Storage, by contrast, is nonvolatile. Its contents remain when power is off.

screen display and contents of most RAM (memory) erased when power is off

contents of storage retained when power is off

**STORAGE TERMS**

| Storage Term | Abbreviation | Number of Bytes |
|---|---|---|
| Kilobyte | KB | 1 thousand |
| Megabyte | MB | 1 million |
| Gigabyte | GB | 1 billion |
| Terabyte | TB | 1 trillion |
| Petabyte | PB | 1 quadrillion |

**Figure 7-3** The capacity of a storage device is measured by the amount of bytes it can hold.

manufacturers use to define the capacity of storage media. A typical floppy disk can store up to 1.44 MB of data (approximately 1.4 million bytes) and a typical hard disk stores 30 GB of data (approximately 30 billion bytes).

Storage requirements among users vary greatly. Small office home office (SOHO) users might need to store a relatively small amount of data. A field sales representative might have a list of names, addresses, and telephone numbers of 50 customers, which he or she uses on a daily basis. Such a list might require no more than a few thousand bytes of storage. Large business users, such as banks, libraries, or insurance companies, often process data for millions of customers and thus might need to store trillions of bytes worth of historical or financial records in their archives.

Numerous types of storage media and storage devices exist to meet a variety of users' needs. Figure 7-4 shows how different types of storage media and memory compare in terms of relative cost and speed. This chapter discusses the storage media in the pyramid, as well as other media.

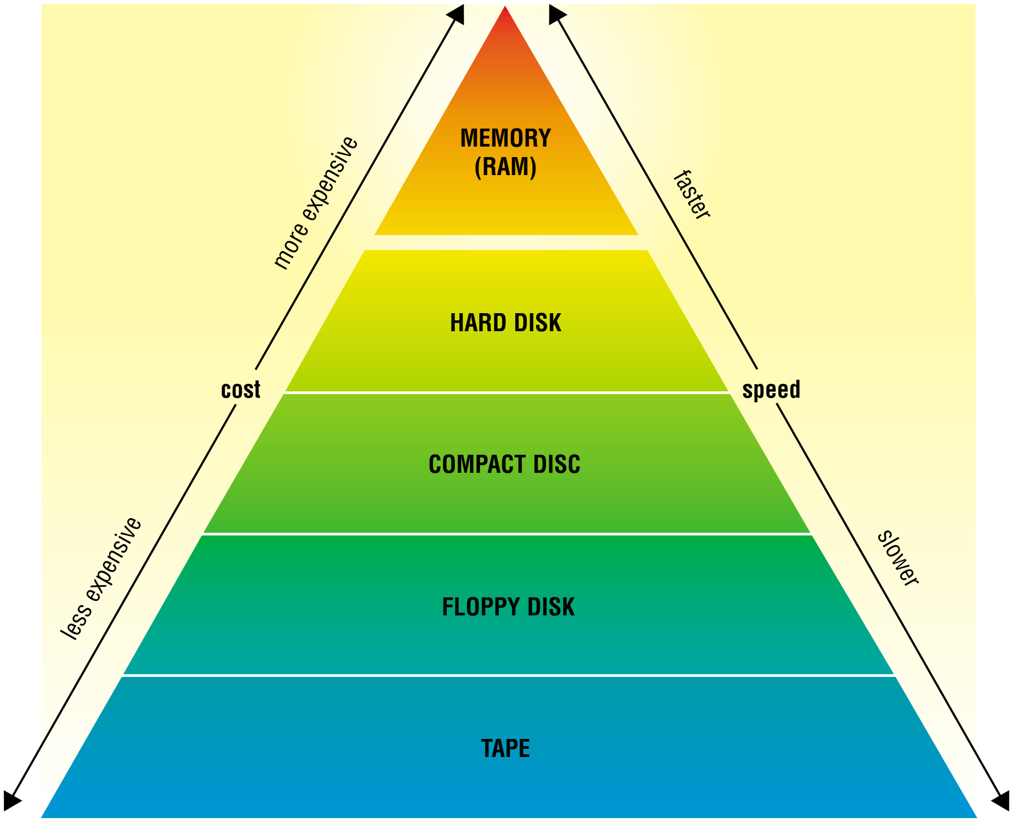


**Figure 7-4** This pyramid shows how different types of storage media and memory compare in terms of relative cost and speed. Memory is faster than storage, but is expensive and not practical for all storage requirements. Storage is less expensive but is slower than memory.

## FLOPPY DISKS

A **floppy disk**, or **diskette**, is a portable, inexpensive storage medium that consists of a thin, circular, flexible plastic disk with a magnetic coating enclosed in a square-shaped plastic shell (Figure 7-5). In the early 1970s, IBM introduced the floppy disk as a new type of storage. These 8-inch wide disks were known as floppies because they had flexible plastic covers. The next generation of floppies looked much the same, but they were only 5.25-inches wide.

Today, the standard floppy disk is 3.5-inches wide and has a rigid plastic outer cover. Although the exterior of the 3.5-inch disk is not floppy, users still refer to them as floppy disks.

A floppy disk is a portable storage medium. When discussing a storage medium, the term portable means you can remove the medium from one computer and carry it to another computer. For example, most personal computers have a floppy disk drive, in which you insert and remove a floppy disk (Figure 7-6).

### Floppy Disk Drives

A **floppy disk drive** (**FDD**) is a device that can read from and write on a floppy disk. Desktop personal computers and many notebook computers have a floppy disk drive installed inside the system unit. Some notebook computers have a removable floppy disk drive, where you can remove the entire drive and replace it with another type of drive or device.

Computers with one floppy disk drive refer to it as *drive A*. Computers that have two floppy disk drives designate the second one as *drive B*.

On a 3.5-inch floppy disk, a piece of metal called the **shutter** covers an opening in the rigid plastic shell (see Figure 7-5). When you insert a floppy disk into a floppy disk drive, the drive slides the shutter to the side to expose a portion of both sides of the floppy disk's recording surface. Never open the disk's shutter and touch its recording surface.

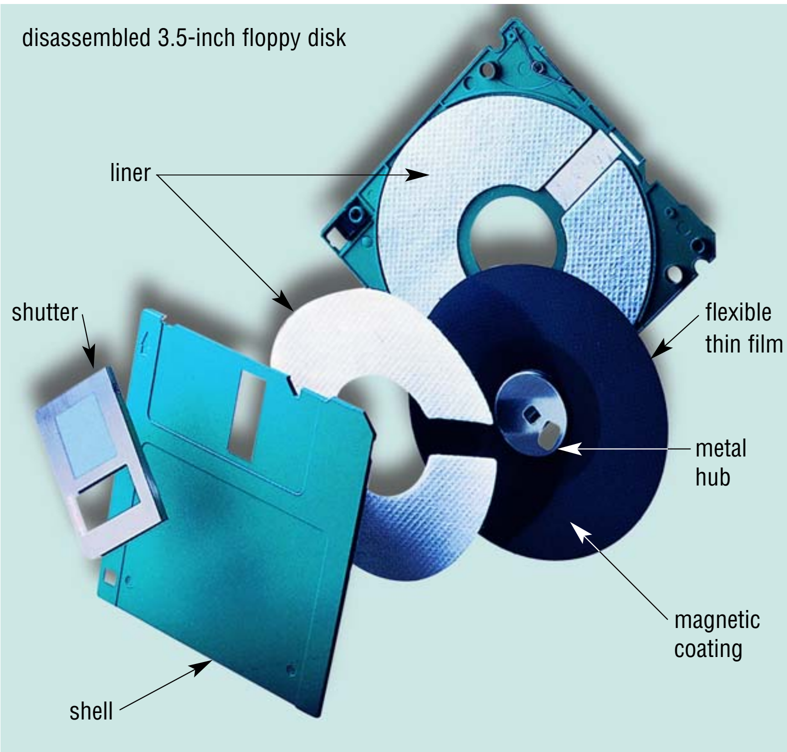


**Figure 7-5** In a 3.5-inch floppy disk, the thin circular flexible film is enclosed between two liners. A piece of metal called a shutter covers an opening to the recording surface in the rigid plastic shell.

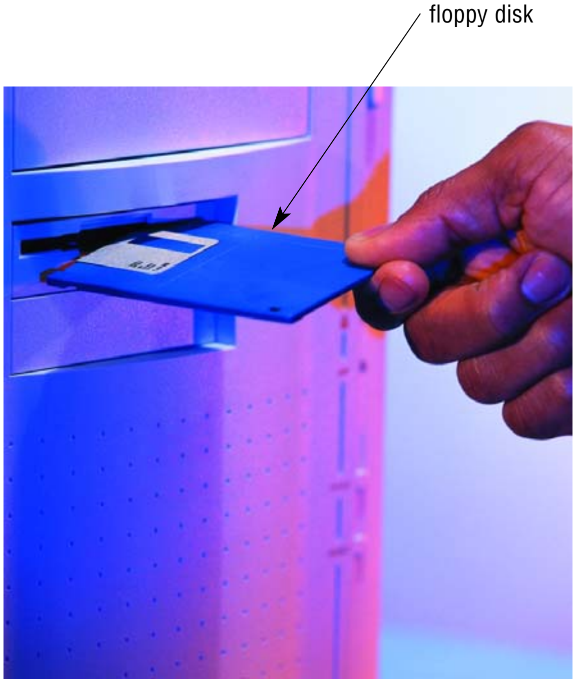


**Figure 7-6** On a personal computer, you insert and remove a floppy disk from a floppy disk drive.

On the front of most floppy disk drives is a light emitting diode (LED) that lights up when the drive is accessing the floppy disk. You should not remove a floppy disk when the LED is lit.

The read/write head in the floppy disk drive is the mechanism that actually reads items from or writes items on the floppy disk. Figure 7-7 illustrates the steps for reading from and writing on a floppy disk. The average time it takes a current floppy disk drive to locate an item on a disk is 84 milliseconds, or approximately 1/12 of a second.

Sometimes, a floppy disk drive will malfunction when it is attempting to access a floppy disk and will display an error message on the screen. If the same error occurs with multiple floppy disks, the read/write heads in the floppy disk drive may have a buildup of dust or dirt. In this case, you can try cleaning the read/write heads using a floppy disk cleaning kit.

To read from or write on a floppy disk, a floppy disk drive must support that floppy disk's density. **Density** is the number of bits in an area on a storage medium. A disk with a higher density has more bits in an area and thus has a larger storage capacity. Most disks today are high density (HD). To access an HD floppy disk, you must have an HD floppy disk drive. An HD floppy disk has a capacity of 1.44 MB. That is, an HD floppy disk can hold up to approximately 1.44 million bytes.

Floppy disk drives are **downward compatible**, which means they recognize and can use earlier media. Floppy disk drives are not **upward compatible**, and thus cannot recognize newer media. For example, a lower-density floppy disk drive cannot read from or write on a high-density floppy disk.

### TECHNOLOGY TRAILBLAZER

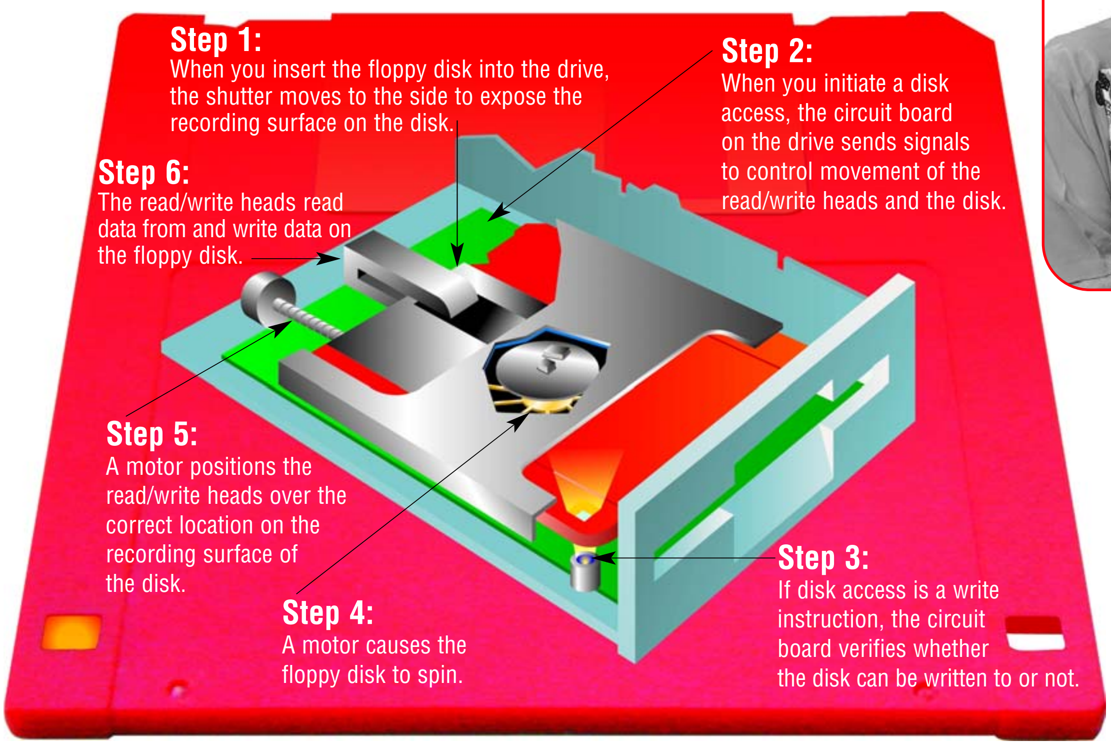
## AL **SHUGART**

Al Shugart has more than 45 years experience in the technology industry.

In 1951, Shugart joined IBM as a customer engineer. In 1955, he became part of a product development program that would have a profound impact on the computer industry. As the company's product manager for random-access memory projects worldwide, Shugart supervised a team in 1967 responsible for developing a removable, portable data storage device. This effort led to the construction of an 8-inch, read-only disk and later to the first read-write disk drive. Shugart left IBM in 1969 and spent the next four years as vice president of product development for Memorex. He founded Shugart Associates in 1973 with the mission to popularize the 8-inch disk drive and mass produce it for the commercial market. The following year, Shugart left the company bearing his name and worked as a private consultant to the technology industry until 1979, when he founded Seagate Technology.

For more information on Al Shugart, visit the Discovering Computers 2002 People Web page (**scsite.com/dc2002/people.htm**) and click Al Shugart.

Figure 7-7 HOW A FLOPPY DISK DRIVE WORKS



**Step 1:**
When you insert the floppy disk into the drive, the shutter moves to the side to expose the recording surface on the disk.

**Step 2:**
When you initiate a disk access, the circuit board on the drive sends signals to control movement of the read/write heads and the disk.

**Step 3:**
If disk access is a write instruction, the circuit board verifies whether the disk can be written to or not.

**Step 4:**
A motor causes the floppy disk to spin.

**Step 5:**
A motor positions the read/write heads over the correct location on the recording surface of the disk.

**Step 6:**
The read/write heads read data from and write data on the floppy disk.

**Web Link**

For more information on floppy disks, visit the Discovering Computers 2002 Chapter 7 WEB LINK page (**scsite.com/dc2002/ch7/weblink.htm**) and click Floppy Disks.

## *How a Floppy Disk Stores Data*

A floppy disk is a type of magnetic media. **Magnetic media** uses magnetic patterns to store items such as data, instructions, and information on a disk's surface. Most magnetic disks are read/write storage media. This enables you to access (read) data from and place (write) data on a magnetic disk any number of times, just as you can with an audiocassette tape.

A floppy disk stores data in tracks and sectors (Figure 7-8). A **track** is a narrow recording band that forms a full circle on the surface of the disk. The disk's storage locations consist of pie-shaped sections, which break the tracks into small arcs called **sectors**. A sector can store up to 512 bytes of data. A typical floppy disk stores data on both sides of the disk, has 80 tracks on each side of the recording surface, and 18 sectors per track.

You can compute a disk's storage capacity by multiplying together the number of sides on the disk, the number of tracks on the disk, the number of sectors per track, and the number of bytes in a sector. For example, the formula for a high-density 3.5-inch floppy disk is as follows: 2 (sides) x 80 (tracks) x 18 (sectors per track) x 512 (bytes per sector) = 1,474,560 bytes (Figure 7-9). Some disks store system files in some tracks, which means the available capacity on a disk may be less than the total possible capacity.

Given the actual number of available bytes on a floppy disk (1,474,560), you may question why manufacturers call them 1.44 MB disks. The 1.44 MB is not a rounding of the 1,474,560. Instead, it is a result of doubling 720 MB, which is the capacity of a low-density 3.5-inch floppy disk.

For reading and writing purposes, sectors are grouped into clusters. A **cluster** is the smallest unit of disk space that stores data. Each cluster, also called an **allocation unit**, consists of two to eight sectors (the number varies depending on the operating system). Even if a file consists of only a few bytes, it uses an entire cluster. Each cluster holds data from only one file. One file, however, can span many clusters.

Sometimes, a sector has a flaw and cannot store data. When you format a disk, the operating system marks these bad sectors as unusable. **Formatting** is the process of preparing a disk for reading and writing. Chapter 8 discusses the formatting process in more depth.

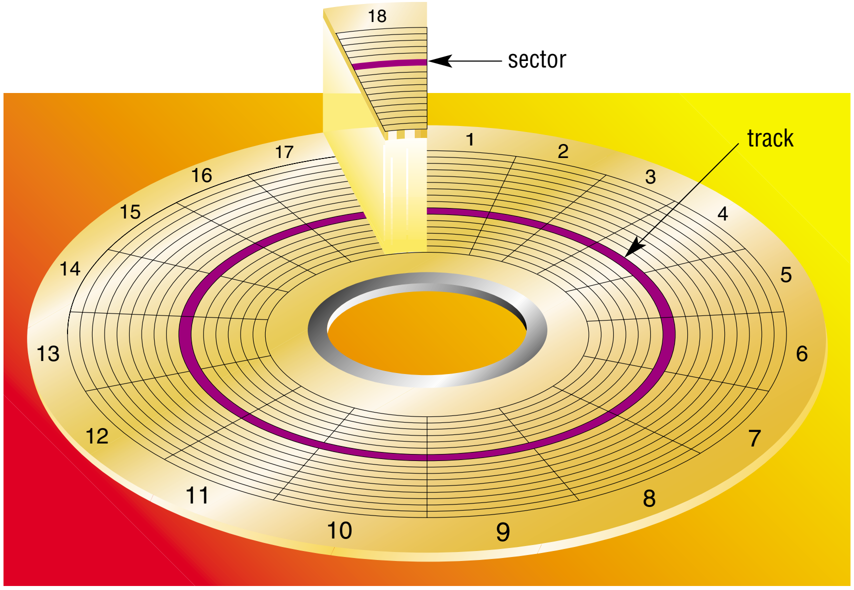


**Figure 7-8** A track is a narrow recording band that forms a full circle on the surface of a disk. The disk's storage locations then are divided into pie-shaped sections, which break the tracks into small arcs called sectors.

**CHARACTERISTICS OF A 3.5-INCH HIGH-DENSITY FLOPPY DISK**

| | |
|---|---|
| Capacity | 1.44 MB |
| Sides | 2 |
| Tracks | 80 |
| Sectors per track | 18 |
| Bytes per sector | 512 |
| Sector per disk | 2880 |

**Figure 7-9** Most of today's personal computers use high-density disks.

### Care of Floppy Disks

Floppy disks provide an inexpensive and reliable form of storage. Disk manufacturers state that a floppy disk can last at least seven years, with reasonable care. In many cases, the disks do not have that long of a life span.

To maximize a disk's life, you should take proper care of it. When handling a floppy disk, avoid exposing it to heat, cold, magnetic fields, and contaminants such as dust, smoke, or salt air. Exposure to any of these elements could damage or destroy the data, instructions, and information stored on the floppy disk. To protect disks further, keep the disks in a storage tray when not using them.

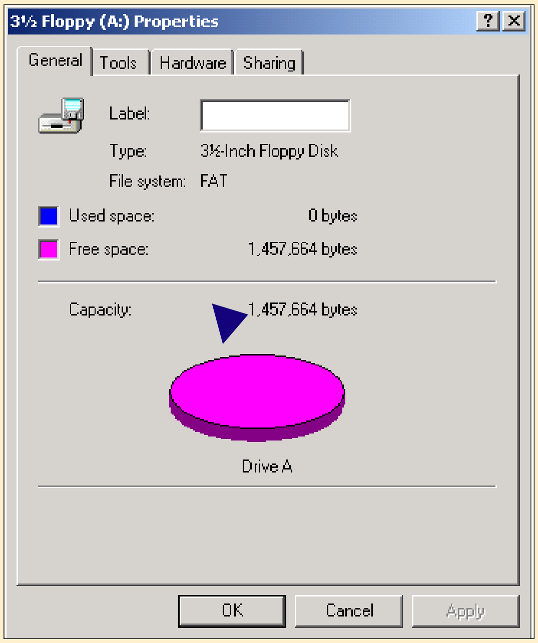
To protect floppy disks from accidentally being erased, the disk's plastic outer cover has a write-protect notch in its corner. A **write-protect notch** is a small opening that has a tab you slide to cover or expose the notch (Figure 7-10). The write-protect notch works much like the recording tab on a VHS tape: if you remove the recording tab, a VCR cannot record onto the VHS tape.

On a floppy disk, if the write-protect notch is open, the drive cannot write on the floppy disk. If the write-protect notch is covered, or closed, the drive can write on the floppy disk. The write-protect notch only affects the floppy disk drive's capability of *writing* on the disk. A floppy disk drive can read from a floppy disk whether the write-protect notch is open or closed. Some floppy disks have a second opening on the opposite side of the disk that does not have the small tab. This opening identifies the disk as an HD (high-density) floppy disk.

## HIGH-CAPACITY DISKS

A **high-capacity disk drive** is a disk drive that uses disks with capacities of 100 MB and greater. High-capacity disks allow you easily to transport a large number of files from one computer to another. These disks also can store large graphics, audio, or video files. Another popular use of these disks is to back up important data and information. A **backup** is a duplicate of a file, program, or disk that you can use if the original is lost, damaged, or destroyed.

Three types of high-capacity disk drives are the SuperDisk™ drive, the HiFD™ drive, and the Zip® drive. The first two are downward compatible with floppy disks. That is, SuperDisk™ and HiFD™ drives can read from and write on standard 3.5-inch floppy disks, as well as their own high-capacity disks.



Label:
Type: 3½-Inch Floppy Disk
File system: FAT
🟦 Used space: 0 bytes
🟪 Free space: 1,457,664 bytes
Capacity: 1,457,664 bytes
Drive A

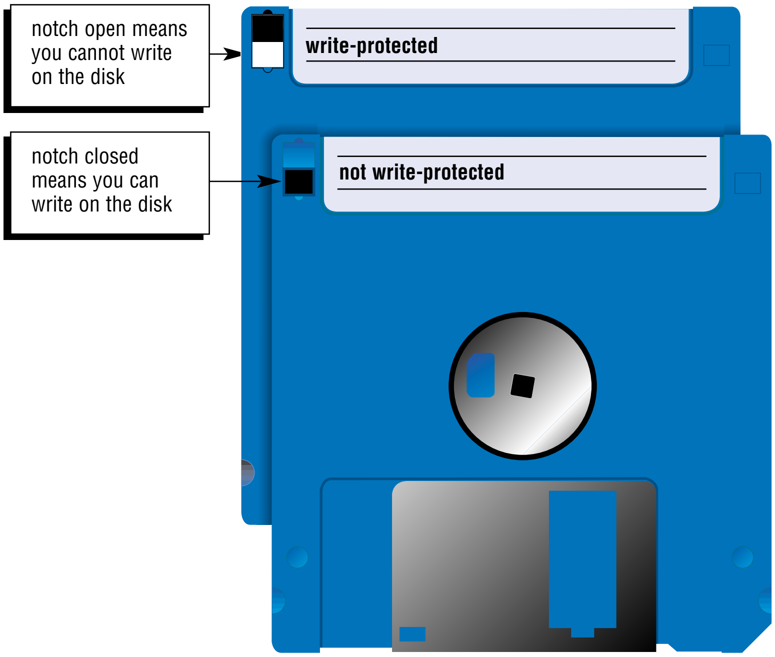

notch open means you cannot write on the disk
notch closed means you can write on the disk
write-protected
not write-protected

**Figure 7-10** To protect data from being erased accidentally, floppy disks have a write-protect notch. By sliding a small tab, you either can cover or expose the notch.

Many notebook computers offer a SuperDisk™ drive or a HiFD™ drive as an option. Developed by Imation, a **SuperDisk™ drive** reads from and writes on a 120 MB or a 250 MB SuperDisk™. Some digital cameras have built-in SuperDisk drives to allow storage of hundreds of photographs on a single disk. The **HiFD™ (High-Capacity Floppy Disk) drive**, developed by Sony Electronics Inc., reads from and writes on a 200 MB HiFD™ disk.

A **Zip® drive** is a high-capacity disk drive developed by Iomega Corporation that uses a Zip® disk. A **Zip® disk** is slightly larger than and about twice as thick as a 3.5-inch floppy disk, and can store 100 MB or 250 MB of data. Many desktop computers have a built-in Zip® drive as a standard feature (Figure 7-11). Others offer it as an option. You also can connect an external Zip® drive to a notebook or desktop computer to provide even more portability.

## HARD DISKS

When personal computers were introduced, software programs and their related files fit easily on a single floppy disk. With these programs, you simply inserted the disk to use the program. Throughout time, software became more complex and included graphical user interfaces and multimedia. Users no longer could run programs from a floppy disk. Instead, they installed the program, which consumed many floppy disks, onto the hard disk. Hard disks provide far greater storage capacities and much faster access times than floppy disks.

A **hard disk**, also called a **hard disk drive**, consists of several inflexible, circular platters that store items electronically. Made of aluminum, glass, or ceramic, a **platter** is coated with a material that allows items to be recorded magnetically on its surface. The platters, along with the read/write heads, and the mechanism for moving the heads across the surface of the hard disk, are enclosed in an airtight, sealed case to protect them from contamination.

Most desktop personal computers contain at least one hard disk. The hard disk inside the system unit, sometimes called a **fixed disk**, is not portable (Figure 7-12). A section later in this chapter discusses another type of hard disk: a removable hard disk.

Current personal computer hard disks can store from 10 to 75 GB of data, instructions, and information. Like floppy disks, these hard disks store data magnetically. Hard disks also are read/write storage media. That is, you can both read from and write on a hard disk any number of times. A recently developed hard disk, called an **optically-assisted hard drive**, combines laser and optic technologies with the magnetic media. These optically-assisted hard drives have potential storage capacities of up to 280 GB.

**Figure 7-11** Many new computers have a built-in Zip® drive.

**Web Link**

For more information on Zip® drives, visit the Discovering Computers 2002 Chapter 7 WEB LINK page (**scsite.com/dc2002/ch7/weblink.htm**) and click Zip® Drives.

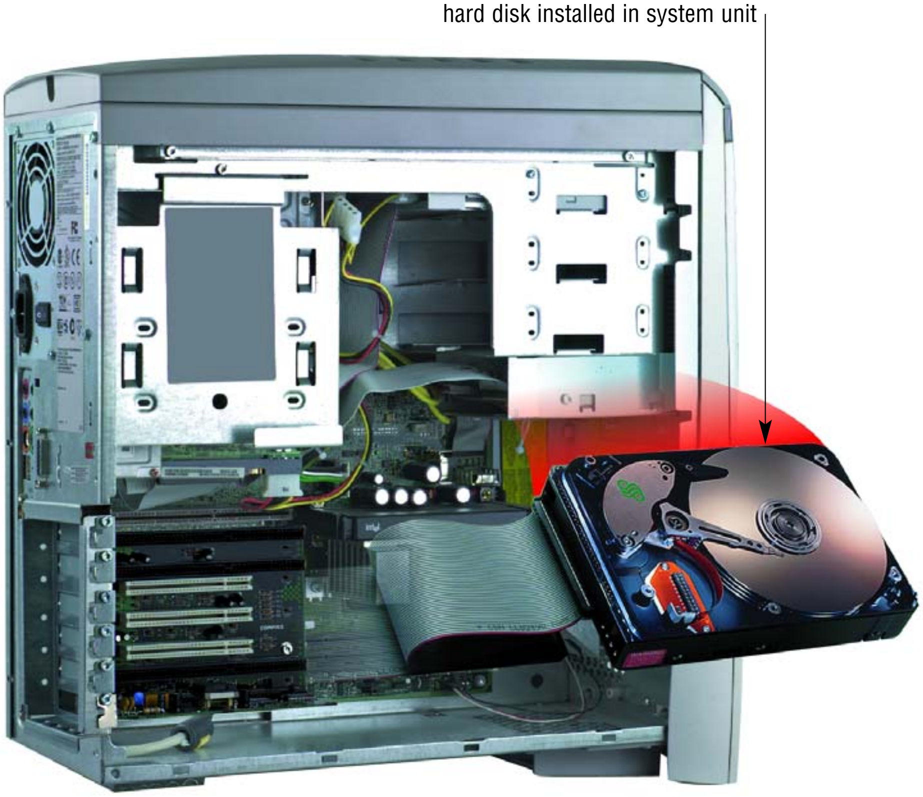


**Figure 7-12** The hard disk in a desktop personal computer normally resides permanently inside the system unit. That is, it is not portable.

### *How a Hard Disk Works*

Most hard disks have multiple platters stacked on top of one another. Each platter has two read/write heads, one for each side. The hard disk has arms that move the read/write heads to the proper location on the platter (Figure 7-13).

The location of the read/write heads often is referred to by its cylinder. A **cylinder** is the location of a single track through all platters (Figure 7-14). For example, if a hard disk has 4 platters (8 sides), each with 1,000 tracks, then it will have 1,000 cylinders with each cylinder consisting of 8 tracks (2 for each platter). A single movement of the read/write head arms can read all the platters of data.

While your computer is running, the platters in the hard disk rotate at a high rate of speed, usually 5,400 to 7,200 revolutions per minute. The platters typically continue spinning until power is removed from the computer. (On some computers, the hard disk turns off after a specified time period to save power.) The spinning motion creates a cushion of air between the platter and its read/write head. This cushion ensures that the read/write head floats above the platter instead of making direct contact with the platter surface. The distance between the read/write head and the platter is approximately two millionths of an inch.

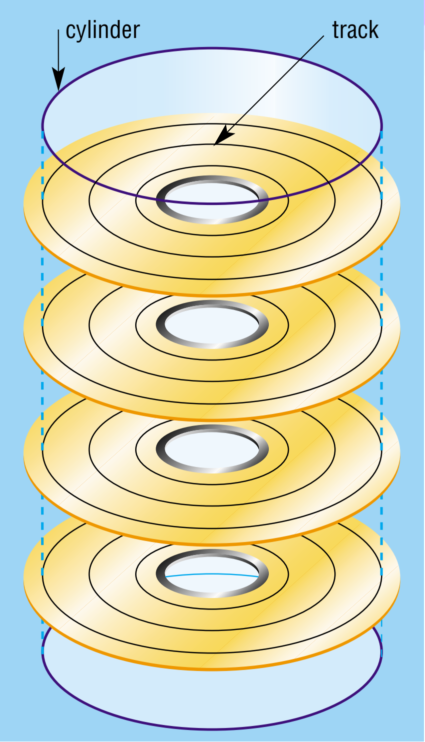
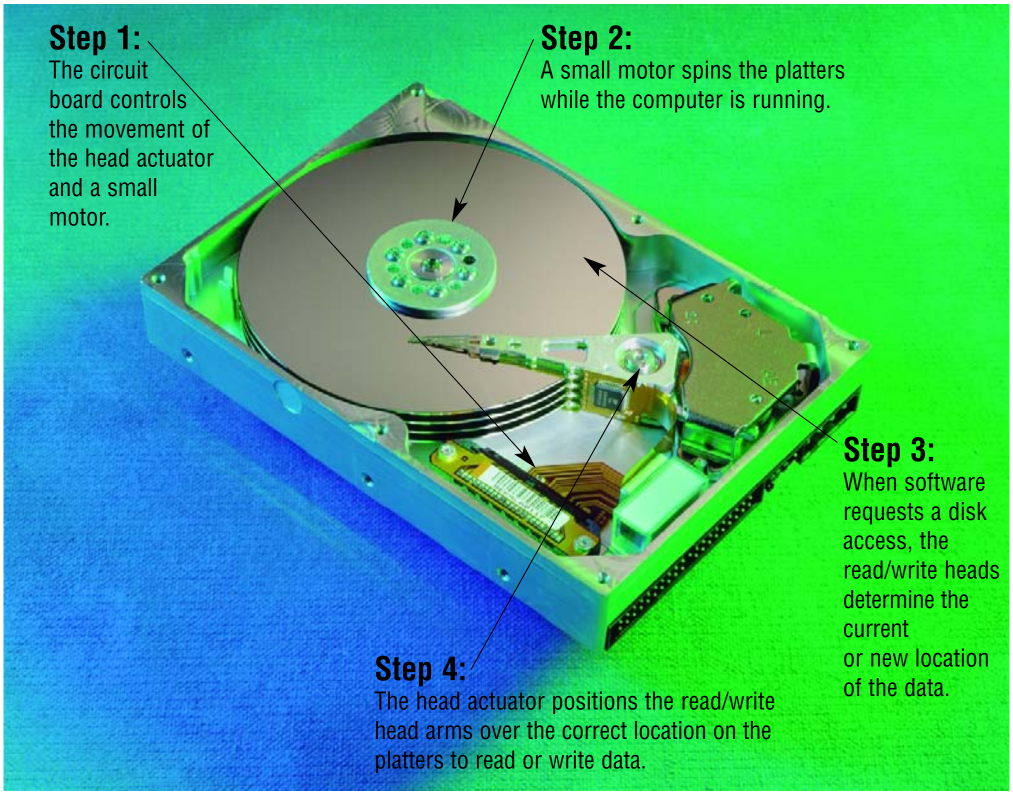


**Figure 7-14** A cylinder is the location of a single track through all platters on a hard disk.

**Figure 7-13 HOW A HARD DISK WORKS**


**Step 1:**
The circuit board controls the movement of the head actuator and a small motor.
**Step 2:**
A small motor spins the platters while the computer is running.
**Step 3:**
When software requests a disk access, the read/write heads determine the current or new location of the data.
**Step 4:**
The head actuator positions the read/write head arms over the correct location on the platters to read or write data.

**Web Link**

For more information on hard disks, visit the Discovering Computers 2002 Chapter 7 WEB LINK page (**scsite.com/dc2002/ch7/weblink.htm**) and click Hard Disks.

As shown in Figure 7-15, this close clearance leaves no room for any type of contamination. Dirt, hair, dust, smoke, and other contaminants could cause the hard disk to have a head crash. A **head crash** occurs when a read/write head touches the surface of a platter, usually resulting in a loss of data or sometimes loss of the entire drive. Today's hard disks are built to withstand shocks and are sealed tightly to keep out contaminants, which means head crashes are less likely to occur.

Access time for today's hard disks ranges from approximately 5 to 11 milliseconds. A hard disk's access time is significantly faster than a floppy disk for two reasons: (1) a hard disk spins much faster than a floppy disk and (2) a hard disk spins constantly, while a floppy disk starts spinning only when it receives a read or write command.

Some computers improve hard disk access time by using disk caching. **Disk cache** (pronounced cash) is a portion of memory that the processor uses to store frequently accessed items (Figure 7-16). Disk cache works similarly to memory cache. When a program needs data, instructions, or information, the processor checks the disk cache. If the item is in disk cache, the processor uses that item and completes the process. If the processor does not find the requested item in the disk cache, then the processor must wait for the hard disk drive to locate and transfer the item from the disk to the processor.

A **cache controller** manages cache and thus determines which items cache should store. On newer processors, the cache controller is part of the processor.

Some disk caching systems also attempt to predict what data, instructions, or information might be needed and place them into cache before the processor requests them. Almost all new disk drives work with some amount of disk cache because it significantly improves disk access times.

You can divide a formatted hard disk into separate areas called **partitions** by issuing a special operating system command. Each partition functions as if it were a separate hard disk drive. Users often partition a hard disk so they can install multiple operating systems on the same hard disk.

If a hard disk has only one partition, the operating system designates it as *drive C*. If the hard disk has two partitions, the first partition is *drive C* and the second is *drive D*. Unless specifically requested by the consumer, most manufacturers define a single partition (drive C) on the hard disk.

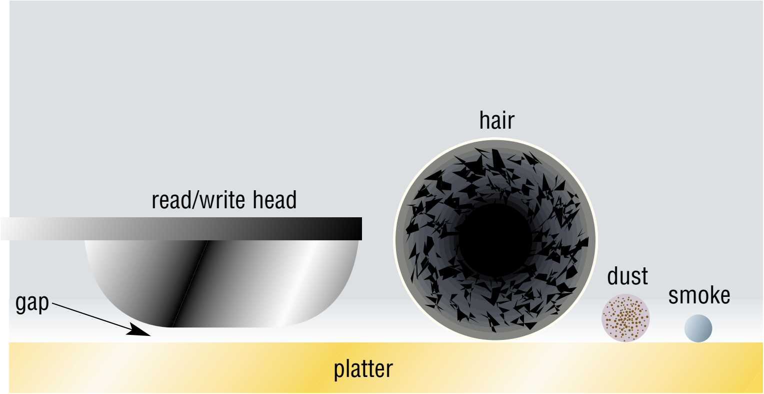


**Figure 7-15** The clearance between a disk read/write head and the platter is about two millionths of an inch. Contaminants, such as a smoke particle, dust particle, or human hair, could render the drive unusable.

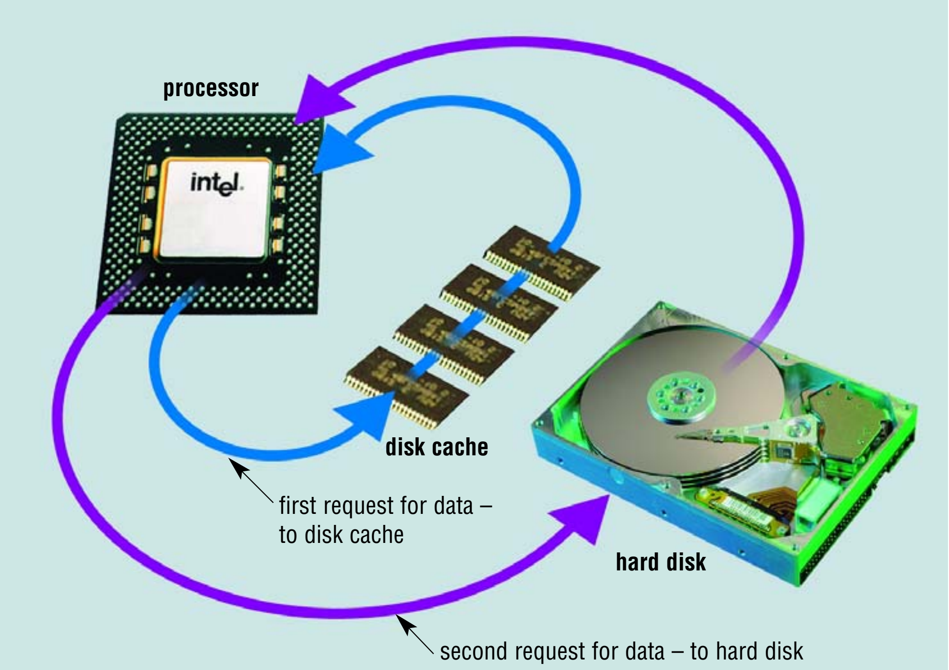

processor
intel
disk cache
first request for data – to disk cache
hard disk
second request for data – to hard disk

**Figure 7-16** When a program needs an item such as data, instructions, or information, the processor checks the disk cache. If the item is located, the processor uses it. If the processor does not find the item in the disk cache, then the processor must wait for the disk drive to locate and transfer the item from the disk.

### *Hard Disk Controllers*

A **disk controller** is a special-purpose chip and associated electronic circuits that control the transfer of data, instructions, and information from a disk to the rest of the computer. Some users refer to the disk controller as an interface.

On a personal computer, a **hard disk controller** (**HDC**) is the interface for a hard disk. The HDC may be part of a disk drive or may be a separate card inside in the system unit. Many external hard drives use a USB port as their interface.

Vendors usually state the HDC interface in their computer advertisements. Thus, you should understand the types of available interfaces. In addition to USB, two types of HDCs for personal computers are EIDE and SCSI.

**EIDE** One of the most widely used controllers for hard disks is the **Enhanced Integrated Drive Electronics** (**EIDE**) controller. EIDE controllers can support up to four hard disks at 137 GB per disk. They can transfer data, instructions, and information to and from the disk at rates of up to 66 MB per second.

An earlier type of EIDE controller was **ATA**, which is short for AT Attachment. Some manufacturers market their EIDE controllers as Fast ATA. EIDE controllers are backward compatible with earlier IDE and ATA controllers. Various versions include ATA, ATA-4, Ultra ATA, Ultra DMA, and ATA/66.

**SCSI** **Small computer system interface**, or **SCSI**, (pronounced scuzzy) controllers can support multiple disk drives, as well as other peripherals such as scanners high-capacity disk drives, CD-ROM drives, CD-RW drives, DVD-ROM drives, tape drives, printers, scanners, network interface cards, and much more. When using SCSI devices, you can daisy chain devices together by connecting the first SCSI device to the computer, the second SCSI device to the first SCSI device, and so on. Some computers have a built in SCSI controller, while others use an expansion card to add a SCSI controller.

SCSI controllers are faster than EIDE controllers, providing up to 160 MB per second transfer rates. SCSI controllers typically cost a few hundred dollars more than do EIDE controllers. Many versions of SCSI controllers exist, including SCSI-3, Wide SCSI, Fast SCSI, Fast Wide SCSI, Ultra SCSI, Ultra2 SCSI, and Ultra 160 SCSI. These SCSI controllers typically are backward compatible with earlier SCSI devices.

### *Removable Hard Disks*

Some hard disks are removable, which enables you to insert and remove the hard disk from a hard disk drive, much like a floppy disk. A **removable hard disk**, also called a **disk cartridge**, is a disk drive in which a plastic or metal case surrounds the hard disk so you can remove it from the drive (Figure 7-17). A popular, reasonably priced, removable hard disk is the **Jaz® disk** by Iomega. A Jaz® disk can store up to 2 GB of data, instructions, and information.

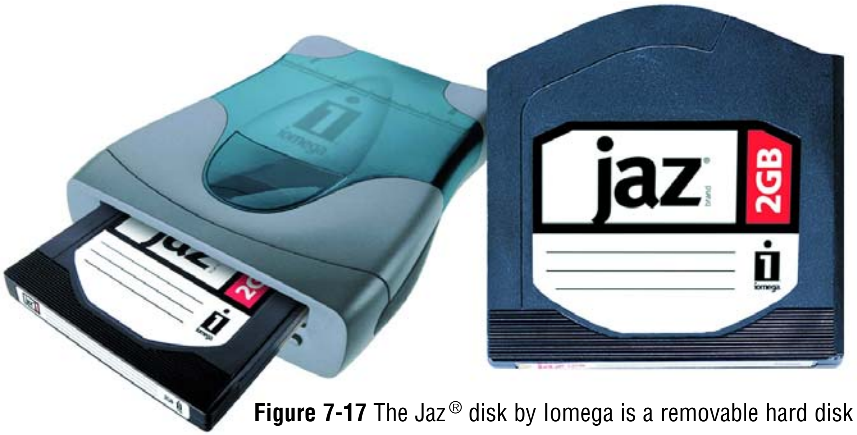


**Figure 7-17** The Jaz® disk by Iomega is a removable hard disk with a storage capacity of up to 2 GB.

### *COMPANY ON THE CUTTING EDGE*

Kingston TECHNOLOGY
COMPUTING WITHOUT LIMITS

#### *Memory in the Making*

Ever sit down to take a test, have your mind go blank, and wonder if you were losing your memory?

The computer industry also thought it was losing its memory in 1987. At that time, memory for personal computers was scarce. John Tu and David Sun knew they could help solve the problem. They founded Kingston Technology and designed a standard single inline memory module (SIMM) using a readily available alternative chip.

As the memory shortage eased a few years later, Kingston branched into manufacturing processor upgrades, storage subsystems, and networking solutions. Today, Kingston is the world's leading independent manufacturer of memory products for computers, servers, digital cameras, and other electronic devices. With annual sales of more than $1.5 million in 1999, Kingston markets more than 2,000 products.

*Fortune* magazine has honored Kingston as one of the 100 Best Companies to Work for in the United States. Part of this honor is due to Kingston's company philosophy of treating all employees as family members and of displaying such traits as courtesy, honesty, and compassion.

For more information on Kingston Technology, visit the Discovering Computers 2002 Companies Web page (**scsite.com/dc2002/companies.htm**) and click Kingston.

Portable media, such as floppy disks and other removable disks, have several advantages over fixed disks. First, you can use a removable disk to transport a large number of files or to make backup copies of important files. You also can use removable disks when data security is an issue. For example, at the end of a work session, you can remove the hard disk and lock it up, leaving no data in the computer.

## *RAID*

For applications that depend on reliable data access, it is crucial the data is available when a user attempts to access it. Some manufacturers develop a type of hard disk system that connects several smaller disks into a single unit that acts like a single large hard disk. A group of two or more integrated hard disks is called a **RAID** (**redundant array of independent disks**). Although quite expensive, a RAID system is more reliable than a traditional disk system (Figure 7-18). Thus, networks and Internet servers often use RAID.

RAID duplicates data, instructions, and information to improve data reliability. RAID systems implement this duplication in different ways, depending on the storage design, or level, used. (These levels are not hierarchical. That is, higher levels are not necessarily better than lower levels.) The simplest RAID storage design is **level 1**, called **mirroring**, which has one backup disk for each disk (Figure 7-19a). A level 1 configuration enhances system reliability because, if a drive should fail, a duplicate of the requested item is available elsewhere within the array of disks.

Levels beyond level 1 use a technique called **striping**, which splits data, instructions, and information across multiple disks in the array (Figure 7-19b). Striping improves disk access times, but does not offer data duplication. For this reason, some RAID levels combine both mirroring and striping.

**Figure 7-18** A group of two or more integrated hard disks, called a RAID (redundant array of independent disks), often is used with network servers. Shown here is a desktop RAID. Figure 7-1 on page 7.3 shows a rack-mount RAID.

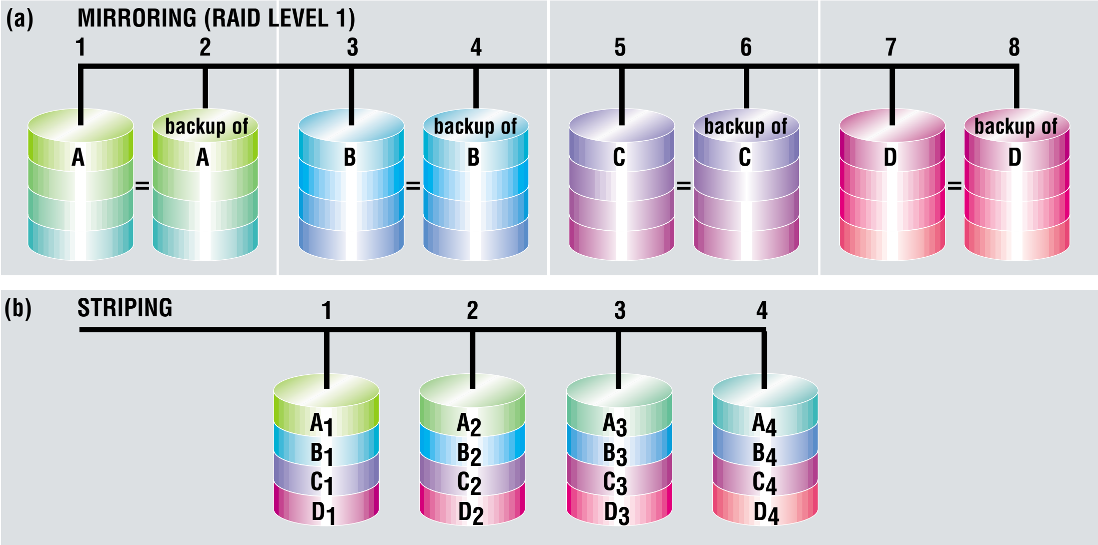


**Figure 7-19** In RAID level 1, called mirroring, a backup disk exists for each disk. Higher RAID levels use striping; that is, portions of each disk are placed on multiple disks.

### *Maintaining Data Stored on a Hard Disk*

Most manufacturers guarantee their hard disks to last somewhere between three and five years. Many last much longer with proper care. To prevent the loss of items stored on a hard disk, you should perform preventative maintenance such as defragmenting or scanning the disk for errors. As shown in the table in Figure 7-20, operating systems such as Windows provide many maintenance and monitoring utilities. Chapter 8 discusses these and other utilities in more depth.

**Web Link**

For more information on disk utilities, visit the Discovering Computers 2002 Chapter 7 WEB LINK page (**scsite.com/dc2002/ch7/weblink.htm**) and click Disk Utilities.

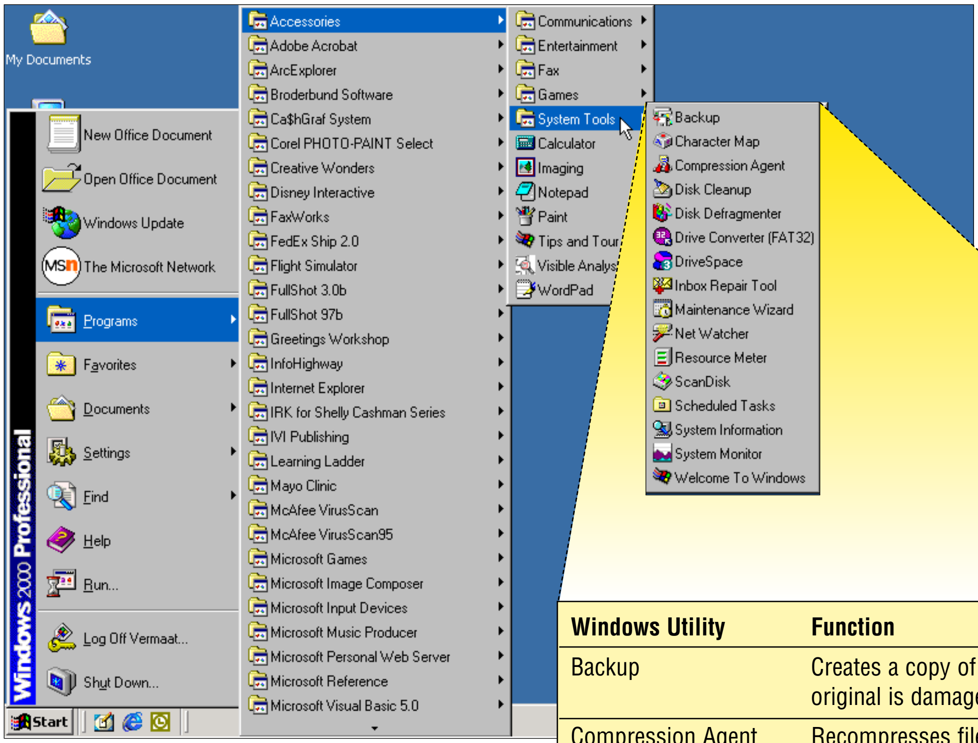


**Figure 7-20** Windows provides many maintenance and monitoring utilities on the System Tools submenu. The table in this figure briefly describes some of these utilities.

| **Windows Utility** | **Function** |
|---|---|
| Backup | Creates a copy of files on a hard disk in case the original is damaged or destroyed. |
| Compression Agent | Recompresses files according to settings in DriveSpace (see below). |
| Disk Cleanup | Frees up space on a hard disk by listing files that can be deleted safely. |
| Disk Defragmenter | Reorganizes files and unused space on a hard disk so programs run faster. |
| Drive Converter (FAT 32) | Improves the FAT method of storing data, which frees up hard disk space and makes programs load faster. |
| DriveSpace | Compresses a hard disk or floppy disk to create free space on the disk. |
| Maintenance Wizard | Runs utilities that optimize your computer's performance. |
| Net Watcher | Monitors users and disk/file usage when computers are networked. |
| Resource Meter | Monitors system, user, and graphics resources being used by programs. |
| ScanDisk | Detects errors on a disk and then repairs the damaged areas. |
| Scheduled Tasks | Automatically runs a utility at a specified time. |
| System Monitor | Monitors disk access, the processor, memory, and network usage. |

## *Internet Hard Drives*

Instead of storing data locally on your fixed or removable hard disk, you can opt to store it on an Internet hard drive. An **Internet hard drive**, sometimes called **online storage**, is a service on the Web that provides storage to computer users (Figure 7-21). Many offer storage free of charge to the consumer. Revenues come from advertisers on the site.

Users store data and information on an Internet hard drive for a variety of reasons:

- You no longer need to transport files while away from your desktop computer. Simply copy files to an Internet hard drive and access them from any computer or device that has Web access.
- As you surf the Web, you may spend a lot of time downloading or saving files on your computer's hard disk. Instead, you can save the large audio, video, and graphics files on an Internet hard drive instantaneously.
- As an alternative to e-mailing attachments to family, friends, co-workers, and customers, you can save the attachment on an Internet hard drive. Recipients of your e-mail message can visit your Internet hard drive to play an audio file, watch the video clip, or view a picture.
- View time-critical data and images immediately while away from the main office or location. For example, doctors can view x-ray images from another hospital, home, office, or while on vacation.
- You easily can store offsite backups of data. Chapter 8 presents this and other backup strategies.

In addition to storage space, these Web sites offer other services. These services often include e-mail, calendar, address book, and task list applications. As with other files on the Internet hard drive, you can share your calendars, address books, and tasks lists with others that have Web access.

### *APPLY IT!*

### Use an Internet Hard Drive to Extend Your Disk Drive Space

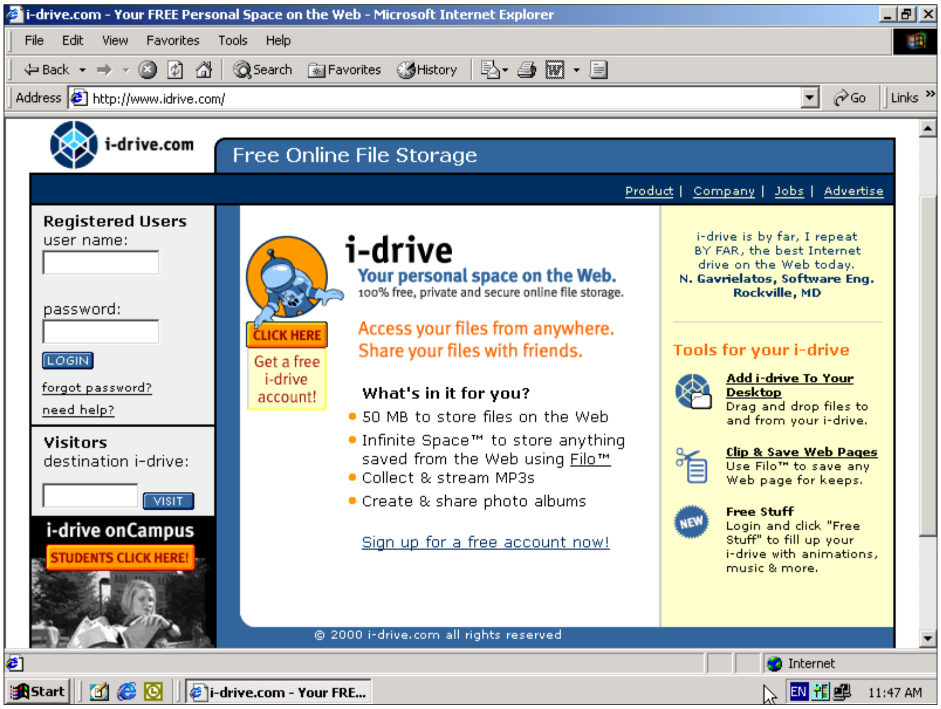
If you are looking for extra disk drive space, a file backup service, or a way to share files with others, you may want to consider one of the free Internet hard drive services. One of the most popular of these is i-drive (see URL below). Using i-drive, you can do the following:

- Save music files, create a play list, and play the songs from i-drive
- Create an online photo album to share with your family and friends
- Save games and other software programs
- Save entire Web pages

To use i-drive, first set up your free account by filling out a short online form. Record your ID and password, log on, and you are ready to go. Click a button to access, setup, and use the following features:

1. Add an i-drive icon to your desktop so that you can drag-and-drop files to your i-drive the same way you drag-and-drop within Windows.
2. Create a Play List folder or a New Photo Album and make these available for public, private, or shared access.
3. Download and install Filo, free downloadable software that lets you clip Web pages, images, files, and links straight to your i-drive or bookmark directly to your i-drive.
4. Use i-drive and access your files from any computer with Web access.

For links to Internet hard drive services and the Web site mentioned above, visit the Discovering Computers 2002 Apply It Web page (**scsite.com/dc2002/apply.htm**) and click Chapter 7 Apply It #1.


i-drive.com - Your FREE Personal Space on the Web - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Search Favorites History
Address http://www.idrive.com/
Go Links
i-drive.com
Product | Company | Jobs | Advertise
LOGIN
forgot password?
need help?
VISIT
CLICK HERE
STUDENTS CLICK HERE!
NEW
Internet
Start
i-drive.com - Your FRE...
11:47 AM

Free Online File Storage

Registered Users
user name:
password:

Visitors
destination i-drive:

i-drive onCampus

Get a free i-drive account!

i-drive
Your personal space on the Web.
100% free, private and secure online file storage.

Access your files from anywhere.
Share your files with friends.

What's in it for you?
- 50 MB to store files on the Web
- Infinite Space™ to store anything saved from the Web using Filo™
- Collect & stream MP3s
- Create & share photo albums

Sign up for a free account now!

i-drive is by far, I repeat BY FAR, the best Internet drive on the Web today.
N. Gavrielatos, Software Eng.
Rockville, MD

Tools for your i-drive

**Add i-drive To Your Desktop**
Drag and drop files to and from your i-drive.

**Clip & Save Web Pages**
Use Filo™ to save any Web page for keeps.

**Free Stuff**
Login and click "Free Stuff" to fill up your i-drive with animations, music & more.

© 2000 i-drive.com all rights reserved

**Figure 7-21** Shown here is an example of a free Internet hard drive service.

## COMPACT DISCS

In the past, when you purchased software, you received one or more floppy disks that contained the files needed to install or run the software program. As software programs became more and more complex, the number of floppy disks required to store the programs increased, sometimes exceeding 30 disks. These more complex programs required a storage medium with greater capacity. This is why most manufacturers today distribute software programs on compact discs.

A **compact disc** (**CD**), also called an **optical disc**, is a flat, round, portable, metal storage medium that usually is 4.75 inches in diameter and less than one-twentieth of an inch thick. Just about every personal computer today includes some type of compact disc drive installed in a drive bay. These drives read compact discs, including audio CDs.

On these drives, you push a button to slide out a tray, insert your compact disc with the label side up, and then push the same button to close the tray (Figure 7-22). Other convenient features on most of these drives include a volume control button and a headphone jack so you can use stereo headphones to listen to audio without disturbing others nearby.

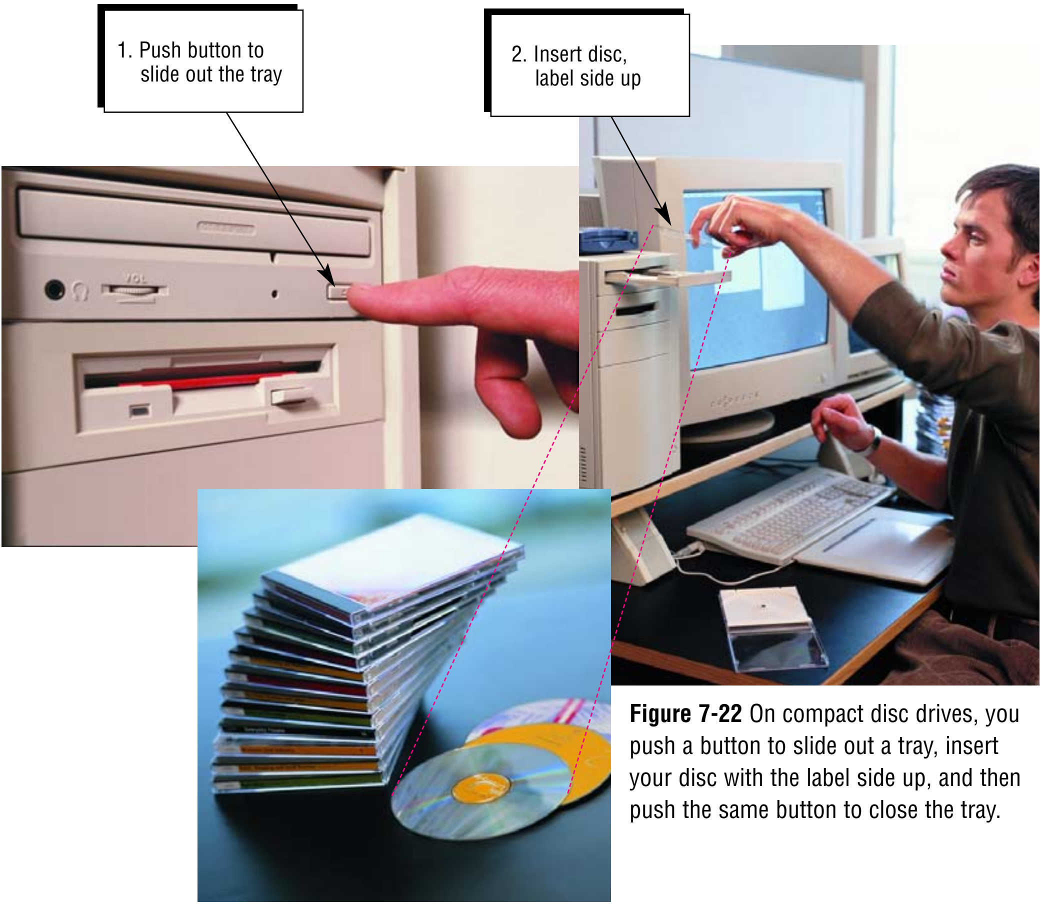

1. Push button to slide out the tray
2. Insert disc, label side up

**Figure 7-22** On compact disc drives, you push a button to slide out a tray, insert your disc with the label side up, and then push the same button to close the tray.

ISSUE

### Web Warehouses

#### Online Storage

Consider the following scenarios: a) You are at work and realize you forgot the electronic files at home for your meeting today; b) You just returned from a fabulous vacation and want to share vacation pictures; or, c) Your computer's hard disk is almost full and you cannot afford to purchase additional storage. One solution is to use one of the free Internet hard drive storage services. Ease of use, number of features, and amount of storage space varies, based on the specific Web site, but you can store information and access it from any Web-enabled computer in the world. Would you store your information on the Internet, instead of on your hard disk? If so, what types of information would you store online? Do you trust the security of these online storage services? What negatives and/or positives could someone encounter with this type of service?

For more information on online storage, visit the Discovering Computers 2002 Issues Web page (**scsite.com/dc2002/issues.htm**) and click Chapter 7 Issue #1.

Recall that a floppy disk drive is designated as drive A. The drive designation of a compact disc drive usually follows alphabetically after that of the hard disk. For example, if the hard disk is drive C, then the compact disc is drive D.

Compact discs store items such as data, instructions, and information by using microscopic pits (indentations) and land (flat areas) that are in the middle layer of the disc (Figure 7-23). (Most manufacturers place a silk-screened label on the top layer of the disc so you can identify it.) A high-powered laser light creates the pits. A lower-powered laser light reads items from the compact disc by reflecting light through the bottom of the disc, which usually is either solid gold or silver in color. The reflected light is converted into a series of bits the computer can process. Land causes light to reflect, which is read as binary digit 1. Pits absorb the light; this absence of light is read as binary digit 0.

A compact disc typically stores items in a single track that spirals from the center of the disc to the edge of the disc. As with a hard disk, this single track is divided into evenly sized sectors in which items are stored (Figure 7-24).

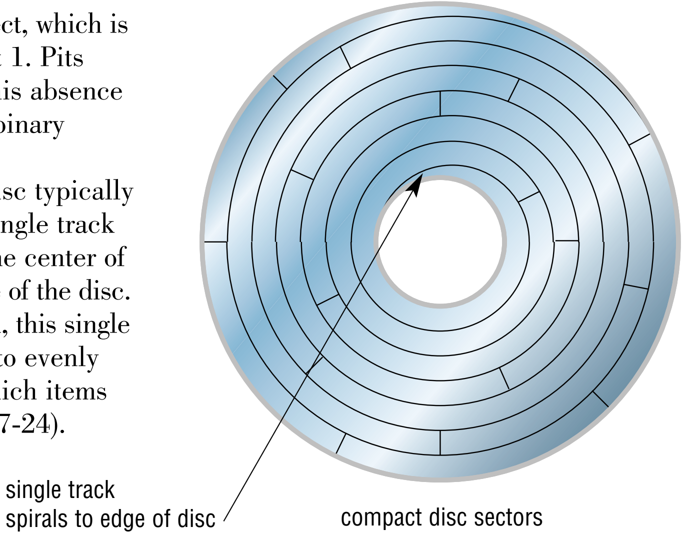
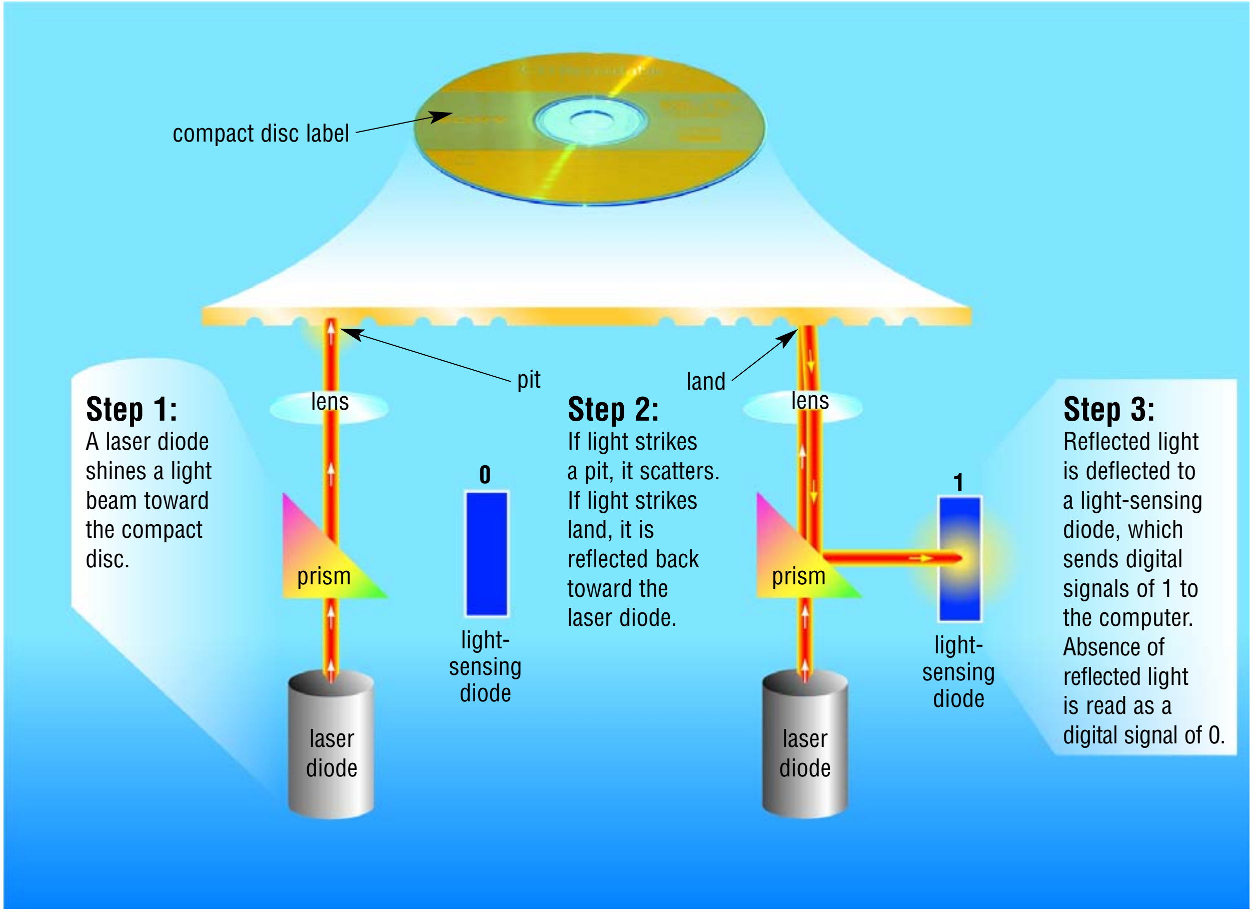


**Figure 7-24** The data on a compact disc often is stored in a single track that spirals from the center of the disc to the edge of a disc.

**Figure 7-23 HOW A LASER READS DATA ON A COMPACT DISC**



**Step 1:**
A laser diode shines a light beam toward the compact disc.

**Step 2:**
If light strikes a pit, it scatters. If light strikes land, it is reflected back toward the laser diode.

**Step 3:**
Reflected light is deflected to a light-sensing diode, which sends digital signals of 1 to the computer. Absence of reflected light is read as a digital signal of 0.

Manufacturers guarantee that a properly cared for compact disc will last five years, but could last up to 50 years. To protect data on any type of compact disc, you should place it in its protective case, called a **jewel box**, when you are finished using it (Figure 7-25). When handling compact discs, you should avoid stacking them and exposing them to heat, cold, and contaminants. Figure 7-26 outlines some guidelines for the proper care of compact discs.

**Figure 7-25** To protect data on a CD, you should place it in a jewel box when you are finished using it.

You can clean the bottom surface of a compact disc with a soft cloth and warm water or a specialized compact disc cleaning kit. You also can repair scratches on the bottom surface with a specialized compact disc repair kit.

Compact discs are available in a variety of formats, including CD-ROM, CD-R, CD-RW, and DVD-ROM. The following pages discuss these basic formats.

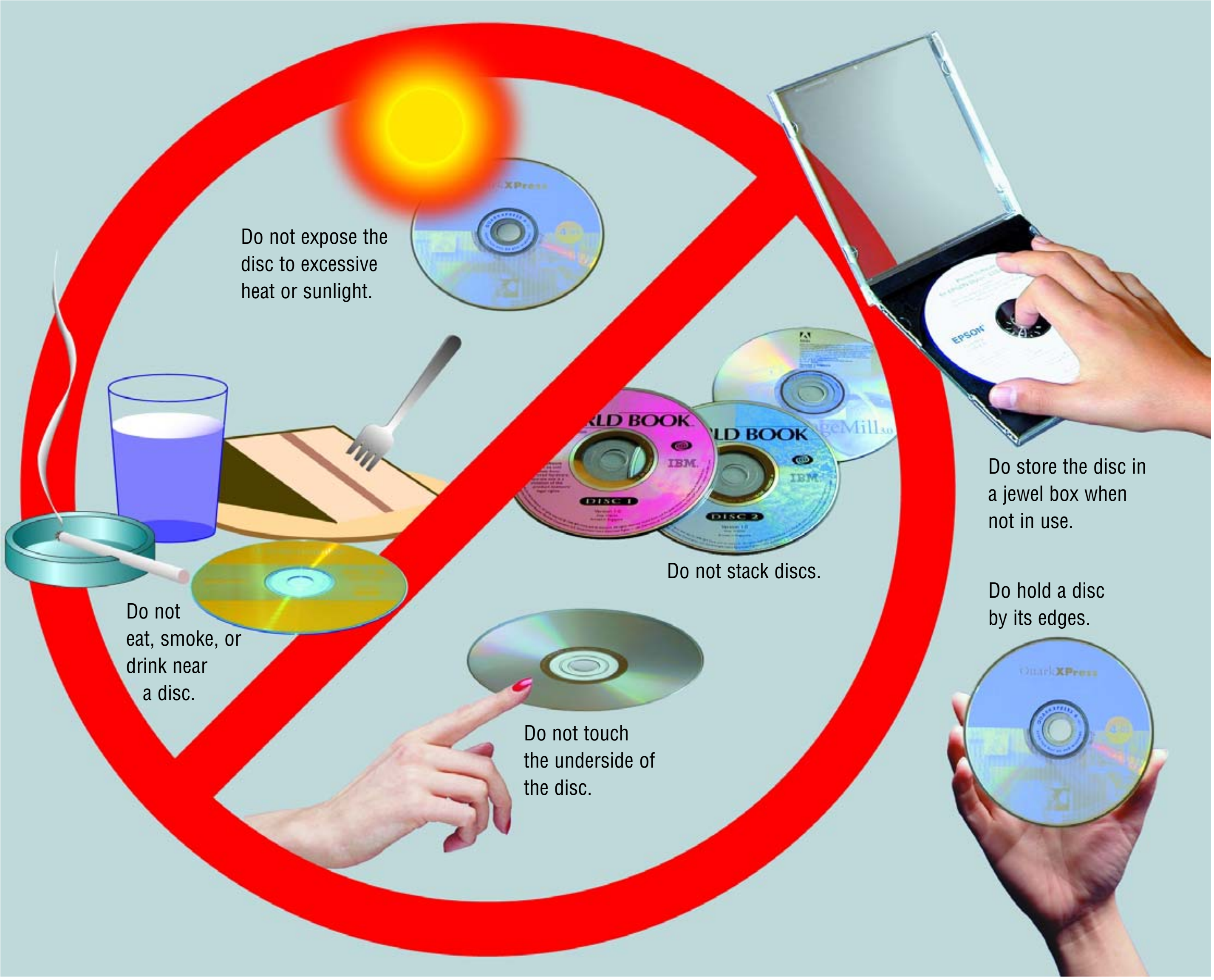

Do not expose the disc to excessive heat or sunlight.
Do not eat, smoke, or drink near a disc.
Do not stack discs.
Do not touch the underside of the disc.
Do store the disc in a jewel box when not in use.
Do hold a disc by its edges.

**Figure 7-26** Some guidelines for the proper care of compact discs.

## CD-ROMs

A **CD-ROM** (pronounced SEE-DEE-rom), or **compact disc read-only memory,** is a silver-colored compact disc that uses the same laser technology as audio CDs for recording music. In addition to audio, a CD-ROM can contain text, graphics, and video. The manufacturer writes, or **records,** the contents of standard CD-ROMs. You only can read the contents of these discs. That is, you cannot erase or modify their contents — hence, the name read-only.

For a computer to read items on a CD-ROM, you must place it into a **CD-ROM drive** or **CD-ROM player.** Because audio CDs and CD-ROMs use the same laser technology, you also can use your CD-ROM drive to listen to an audio CD while working on your computer.

A typical CD-ROM holds about 650 MB of data, instructions, and information. This is about 450 times more than you can store on a high-density 3.5-inch floppy disk. Manufacturers use CD-ROMs to store and distribute today's multimedia and other complex software because these discs have such high storage capacities (Figure 7-27). Some programs even require that the disc be in the drive each time you use the program.

### CD-ROM Drive Speed

The speed of a CD-ROM drive is extremely important when viewing animation or video such as those found in multimedia encyclopedias and games. A slower CD-ROM drive results in choppy images or sound. The data transfer rate is the time it takes a drive to transmit data, instructions, and information from the

**Web Link**

For more information on CD-ROMs, visit the Discovering Computers 2002 Chapter 7 WEB LINK page (**scsite.com/dc2002/ch7/weblink.htm**) and click CD-ROMs.

**Figure 7-27** CD-ROMs are used to store and distribute multimedia and other complex software.

drive to another device. The original CD-ROM drives were single-speed drives with a data transfer rate of 150 KB per second. Manufacturers measure all CD-ROM drives relative to the first CD-ROM drive. An X denotes the original transfer rate of 150 KB per second. For example, a 40X CD-ROM drive has a data transfer rate of 6,000 (40 x 150) KB per second or 6 MB per second.

Current CD-ROM drives have data transfer rates, or speeds, ranging from 40X to 75X. The higher the number, the faster the CD-ROM drive, which results in smoother playback of images and sounds. Faster CD-ROM drives, however, are more expensive than slower drives.

### *PhotoCDs and Picture CDs*

Based on a file format developed by Eastman Kodak, a **PhotoCD** is a compact disc that contains digital photographic images saved in the PhotoCD format. Commercial and professional users work with PhotoCDs. Most professional desktop publishing software packages can read the PhotoCD format.

A PhotoCD is a **multisession** disc, which means you can write additional data, instructions, and information to the disc at a later time. Thus, as users capture more photographs, they can add them to the PhotoCD. (Most standard CD-ROMs are **single-session** because manufacturers write all items to the disc at one time.)

For the home user, Kodak has a Picture CD. A **Picture CD** is a single-session disc that stores digital versions of photographs for consumers. Many film developers offer this service when you drop off film to be developed. That is, in addition to printed photographs and negatives, you also receive a disc containing your pictures (Figure 7-28). The additional cost for a Picture CD is about $10 per roll of film.

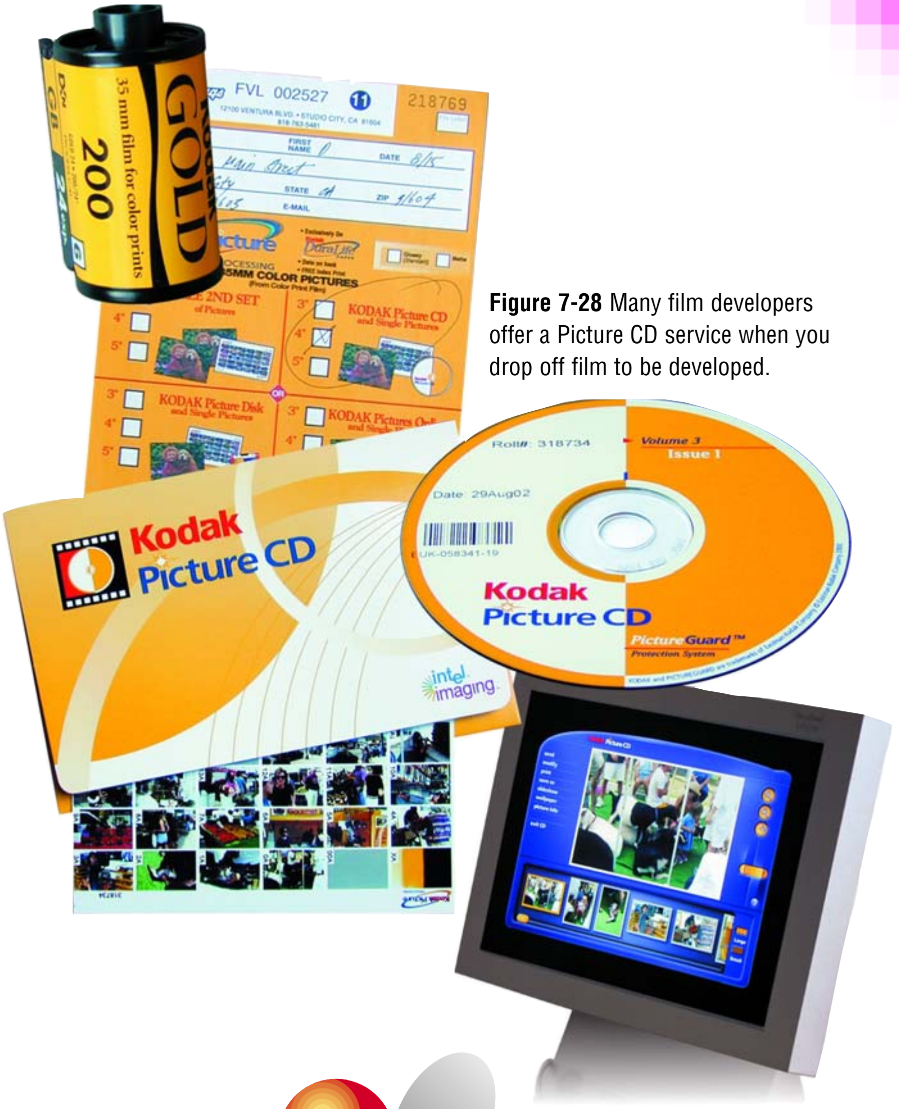


**Figure 7-28** Many film developers offer a Picture CD service when you drop off film to be developed.

ISSUE

## And Your Choice Is?

### CD-ROM or Printed Brochure

Instead of printed brochures, companies increasingly now mail or give marketing CD-ROMs to their potential customers. CD-ROMs are more expensive than conventional advertisements, but the companies feel the storage medium's interactivity is worth the cost in most instances. Some automobile manufacturers, for example, offer a CD-ROM that introduces new vehicles to prospective buyers. The CD-ROM shows photographs, statistics, option packages, and pricing information. Using a mouse, automobile shoppers can *walk around and kick the tires*, view the car from different angles, obtain close-ups of special features, and even go on a figurative test drive. Should companies advertise on CD-ROMs and mail the CD-ROMs to the public? Do people install and read the information on these CD-ROMs? Is a printed brochure more effective? What products are best suited to promotion on CD-ROM? Why? What products are least suited? Why? Will marketing CD-ROMs ever replace printed advertising materials? Why or why not?

For more information on CD-ROMs, visit the Discovering Computers 2002 Issues Web page (**scsite.com/dc2002/issues.htm**) and click Chapter 7 Issue #2.

Using photo-editing software and the photographs on the Picture CD, you can remove red eye, crop the photograph, trim away edges, enhance colors, adjust the lighting, and edit just about any aspect of a photograph. You also can print copies of the photographs on glossy paper with your ink-jet printer. If you want to share the photographs, you can e-mail them, copy them to an Internet hard drive, or post them on a photo community.

**Web Link**

For more information on Picture CDs, visit the Discovering Computers 2002 Chapter 7 WEB LINK page (**scsite.com/dc2002/ch7/weblink.htm**) and click Picture CDs.

## CD-R AND CD-RW

Most computers today include either a CD-R or CD-RW drive as a standard feature. Others offer one of these drives as an option. Unlike standard CD-ROM drives, you can record, or write, your own data onto a disc with a CD-R or CD-RW drive.

A **CD-R** (**compact disc-recordable**) is a multisession compact disc onto which you can record your own items such as text, graphics, and audio. With a CD-R, you can write on part of the disc at one time and another part at a later time. Once you have recorded the CD-R, you can read from it as many times as you wish. You can write on each part only one time, and you cannot erase the disc's contents. Most CD-ROM drives can read a CD-R.

You write on the CD-R using a **CD recorder** or a **CD-R drive** and special software. A CD-R drive can read and write both audio CDs and standard CD-ROMs. These drives read at speeds of up to 24X and write at speeds of up to 8X. Manufacturers often list the write speed first, for example, as 8/24. CD-R drives are slightly more expensive than standard CD-ROM drives.

Instead of CD-R drives, many users opt for CD-RW drives. A **CD-RW** (**compact disc-rewritable**) is an erasable disc you can write on multiple times. Originally called an **erasable CD** (**CD-E**), a CD-RW overcomes the major disadvantage of CD-R disks, which is you can write on them only once. With CD-RW, the disc acts like a floppy or hard disk, allowing you to write and rewrite data, instructions, and information onto it multiple times. To write on a CD-RW disc, you must have CD-RW software and a **CD-RW drive**. These drives have a write speed up to 12X, rewrite speed up to 4X, and a read speed up to 32X. Manufacturers typically state the speeds in this order, for example, as 12/4/32.

CD-RW discs can be read only by multiread CD-ROM drives. A **multiread CD-ROM drive** is a drive that can read audio CDs, data CDs, CD-Rs, and CD-RWs. Most recent CD-ROM drives are multiread.

***APPLY IT!***

**Digital Photographs**

Internet evangelists have long predicted the move to digital and online photograph storage. These predictions now are coming true. One does not even need a scanner or digital camera to participate in the fun.

Picture CD is a new film digitation service from Kodak (see URL below). This technology bridges the film-digital gap by providing a solution that gives people the benefit of both film and digital pictures. Use a Picture CD to view pictures on your computer. You can print or modify, improve, and enhance your photographs, and send e-mail postcards. To purchase a Picture CD, just check the box for KODAK Picture CD on your processing envelope when you take in your film or one-time-use cameras for processing.

Many sites on the Web allow you to create a photo album similar to an album you may have at home. Most of these sites offer free unlimited storage. If you choose, you can share your albums with friends, family, or the entire Internet community. Some sites provide the option of sending electronic greeting cards or postcards.

For more information on Picture CDs, online photograph storage, and the Web site mentioned above, visit the Discovering Computers 2002 Apply It Web page (**scsite.com/dc2002/apply.htm**) and click Chapter 7 Apply It #2.

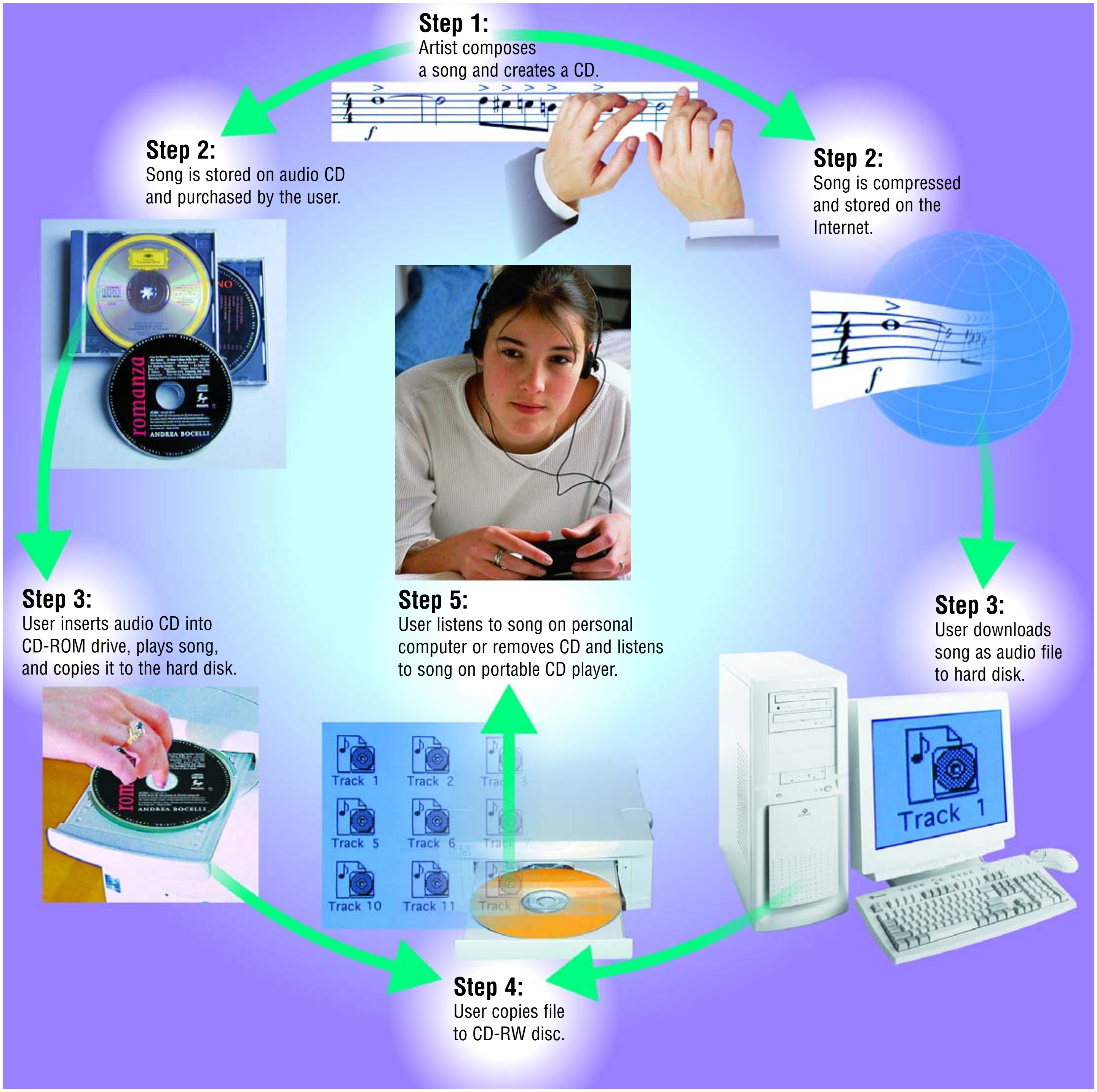
Using a CD-RW disc, you easily can backup large files from your hard disk. You also can share data and information with other users that have a CD-ROM drive.

A very popular use of CD-RW and CD-R discs is to create audio CDs. That is, you can make your own music disc. Users have two basic options to create an audio CD: copy the song(s) from an existing audio CD or download the song(s) from the Web. The steps in Figure 7-29 illustrate these techniques.

**Web Link**

For more information on CD-RWs, visit the Discovering Computers 2002 Chapter 7 WEB LINK page (**scsite.com/dc2002/ch7/weblink.htm**) and click CD-RWs.

**Figure 7-29 HOW TO CREATE AN AUDIO CD**


Step 1:
Artist composes a song and creates a CD.
Step 2:
Song is stored on audio CD and purchased by the user.
Step 2:
Song is compressed and stored on the Internet.
Step 3:
User inserts audio CD into CD-ROM drive, plays song, and copies it to the hard disk.
Step 5:
User listens to song on personal computer or removes CD and listens to song on portable CD player.
Step 3:
User downloads song as audio file to hard disk.
Track 1
Track 2
Track 5
Track 6
Track 10
Track 11
Track 1
Step 4:
User copies file to CD-RW disc.

**APPLY IT!**

### The Future of CD-RW Discs

You probably have seen ads and read about CD-R and CD-RW discs. You may have considered purchasing one of these drives, but wondered how you could use this technology. Consider that 10 years ago the common method of sharing files was via a 5.25-inch floppy disk. Depending on the disk's density, you could store either 360 or 1.2 million characters. With today's increasing need for removable storage, CD-R and CD-RW may become as popular as the floppy disk in its heyday. These drives have more than 400 times the capacity of a floppy disk. They combine the compatibility, flexibility, and storage capacity of a CD with the drag-and-drop ease of a floppy.

CD-R and CD-RW add a new dimension to CD use in computers. You use CD technology to store your data and record your own CDs. With CD-RW, you can erase and rewrite data repeatedly on the same disc. The number of times the disc can be rewritten depends upon the quality of the disc.

Adding one of these drives to any new or existing computer is easy to do. You may find that this technology is perfect for backing up a large set of files, creating music CDs, or creating multimedia presentations. CD-RW drives are able to write both CD-R and CD-RW disc formats. CD-RW discs, however, have two disadvantages: a) they cannot be read by all CD drives; and b) CD-RW discs cannot be written to by CD-R drives.

For more information on CD-R and CD-RW discs, visit the Discovering Computers 2002 Apply It Web page (**scsite.com/dc2002/apply.htm**) and click Chapter 7 Apply It #3.

ISSUE

## Make Your Own Music

### CD-RW Storage

The CD-RW disc opened new possibilities. For multimedia designers and home recording artists, the recordable CD format offers a range of powerful storage applications. Price decreases and ease of use make these devices even more attractive. Along with almost any new technology, negatives exist. At many schools, for example, some students use college servers to create their own music sites and download copyrighted music. Using CD-RW storage, they record the songs and distribute unauthorized copies. Many people think the Internet is a new frontier and copyright rules do not apply. Do you agree with this? Is it ethical to copy a CD and share it with a friend? Is it the responsibility of schools to educate students about such ethical issues? Why or why not?

For more information on CD-RWs, visit the Discovering Computers 2002 Issues Web page (**scsite.com/dc2002/issues.htm**) and click Chapter 7 Issue #3.

## *DVD-ROMS*

Although CD-ROMs have huge storage capacities, even a CD-ROM is not large enough for many of today's complex programs. Some multimedia software, for example, requires five or more CD-ROMs. To meet these tremendous storage requirements, some manufacturers store and distribute software using a DVD-ROM (Figure 7-30). The goal of DVD technology is to meet the needs of home entertainment, computer usage,

**Figure 7-30** A DVD-ROM is an extremely high-capacity compact disc capable of storing 4.7 GB to 17 GB.

and business data and information storage with a single medium. When you rent or buy a DVD movie, it uses a DVD-Video format to store the motion picture digitally.

A **DVD-ROM** (**digital video disc-ROM**) is an extremely high capacity compact disc capable of storing from 4.7 GB to 17 GB. The storage capacity of a DVD-ROM is more than enough to hold a telephone book containing every resident in the United States. Not only is the storage capacity of a DVD-ROM greater than a CD-ROM, a DVD-ROM's quality also far surpasses that of a CD-ROM.

In order to read a DVD-ROM, you must have a **DVD-ROM drive** or **DVD player**. These drives can read at speeds up to 40X. Newer DVD-ROM drives also can read audio CDs, CD-ROMs, CD-Rs, and CD-RWs.

At a glance, a DVD-ROM looks just like a CD-ROM. Although the size and shape are similar, a DVD-ROM stores data, instructions, and information in a slightly different manner and thus achieves a higher storage capacity.

A DVD-ROM uses one of three storage techniques. The first technique involves making the disc more dense by packing the pits closer together. A second technique involves using two layers of pits. For this technique to work, the lower layer of pits is semitransparent so the laser can read through it to the upper layer. This technique doubles the capacity of the disc. Finally, some DVD-ROMs are double-sided, which means you remove the DVD-ROM and turn it over to read the other side. The storage capacities of various types of DVD-ROMs are shown in the table in Figure 7-31.

### *DVD Variations*

DVDs are available in a variety of formats, one of which stores digital motion pictures. To view a movie on a DVD, insert the DVD movie disc into a DVD player connected to your television set or into a DVD-ROM drive to view the movie on your computer screen. Movies on DVD have near-studio-quality video, which far surpasses VHS tapes. When music is stored on a DVD, it includes surround sound and has a much better quality than that on an audio CD.

You also can obtain recordable and rewritable versions of DVD. With a **DVD-R** (**DVD-recordable**), you can write once on it and read (play) it many times. A DVD-R is similar to a CD-R. DVD-R drives have a read speed of up to 32X and a write speed of up to 8X. With a rewritable DVD, called a **DVD-RAM**, you can erase and record on the disc multiple times. A DVD-RAM is similar to a CD-RW, except it has storage capacities up to 5.2 GB. DVD-RAM drives typically can read DVD-ROM, DVD-R, and all CD media. A competing technology to DVD-RAM is **DVD+RW**. As the cost of DVD technologies becomes more reasonable, many industry professionals expect that DVD eventually will replace all CD media.

**DVD-ROM STORAGE CAPACITIES**

| Sides | Layers | Storage Capacity |
|---|---|---|
| 1 | 1 | 4.7 GB |
| 1 | 2 | 8.5 GB |
| 2 | 1 | 9.4 GB |
| 2 | 2 | 17 GB |

**Figure 7-31** Storage capacities of DVD-ROMS.

**TECHNOLOGY TRAILBLAZER**

## MARK **DEAN**

Not many first graders can handle algebra problems. But Mark Dean was no ordinary first grader. Along with solving fourth-grade math equations in his first year of school, he also tutored older students. In high school, he was a straight-A student and a star athlete.

He also spent hours inventing new products. As a youth, he and his dad built a tractor from scratch. After graduating at the top of his class from the University of Tennessee, he joined IBM and helped design the improvements in architecture that allow components, such as modems and printers, to communicate with personal computers. This technology is used in more than 40 million personal computers manufactured each year. After earning his Ph.D. degree at Stanford, he headed a team at IBM that invented the first CMOS microprocessor chip to operate at one gigahertz (1,000 MHz). As an IBM idea man, he currently is developing an electronic tablet that functions as an e-book, DVD player, radio, wireless telephone, and Web-enabled device.

Dean is the first African-American to receive an IBM Fellowship, the company's highest technical ranking. He has been inducted into the National Inventor's Hall of Fame, an honor he shares with fewer than 150 other people.

For more information on Mark Dean, visit the Discovering Computers 2002 People Web page (**scsite.com/dc2002/people.htm**) and click Mark Dean.

## TAPES

One of the first storage media used with mainframe computers was tape. **Tape** is a magnetically coated ribbon of plastic capable of storing large amounts of data and information at a low cost.

Similar to a tape recorder, a **tape drive** reads from and writes data and information on a tape. Although older computers used reel-to-reel tape drives, today's tape drives use tape cartridges. A **tape cartridge** is a small, rectangular, plastic housing for tape (Figure 7-32). Tape cartridges containing one-quarter-inch wide tape are slightly larger than audiocassette tapes. Business and home users sometimes backup personal computer hard disks onto tape.

Some personal computers have external tape units. Others have the tape drive built into the system unit. On larger computers, tape cartridges are mounted in a separate cabinet called a tape library.

Three common types of tape drives are quarter-inch cartridge (QIC), digital audio tape (DAT), and digital linear tape (DLT). The fastest and most expensive of the three is DLT. The table in Figure 7-33 summarizes each of these types of tapes.

Tape storage requires **sequential access**, which refers to reading or writing data consecutively. Like a music tape, you must forward or rewind the tape to a specific point to access a specific piece of data. For example, to access item W, you must pass sequentially through points A through V.

Floppy disks, hard disks, and compact discs all use direct access. **Direct access**, also called **random access**, means you can locate a particular data item or file immediately, without having to move consecutively through items stored in front of the desired data item or file. Sequential access is much slower than direct access. Tapes no longer are used as a primary method of storage. Instead, business and home users utilize tapes most often for long-term storage and backup.

### COMPANY ON THE CUTTING EDGE

EMC²
where information lives

### Big-Time Storage Solutions

When your closet gets too small for your wardrobe, you have two choices: discard some clothes you no longer wear, or find a larger closet. When the world's largest corporations run out of space to store their data, they, too, have two choices: discard some of the files they no longer need, or find additional storage locations. When they choose the latter, chances are they might consider EMC Corporation, a provider of storage systems.

Richard Egan and Roger Marino (the "E" and "M" in EMC) founded EMC in 1979 to fill a demand for add-on memory boards in the minicomputer market. Soon, the company expanded to provide small disk drives using RAID technology for mainframe computers, the industry standard for storage systems today. Other ventures include Symmetrix Remote Data Facility, which provides business continuity and disaster recovery, and more than a dozen storage-based software solutions.

For more information on the EMC Corporation, visit the Discovering Computers 2002 Companies Web page (**scsite.com/dc2002/companies.htm**) and click EMC.

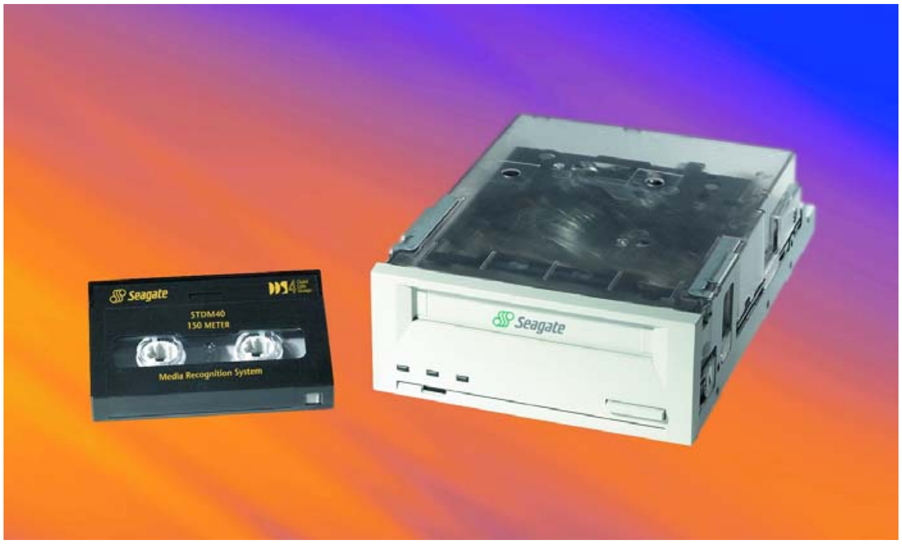


**Figure 7-32** A tape cartridge and a tape drive.

**POPULAR TYPES OF TAPES**

| Name | Abbreviation | Storage Capacity |
|---|---|---|
| Quarter-inch cartridge | QIC | 40 MB to 20 GB |
| Digital audio tape | DAT | 2 to 40 GB |
| Digital linear tape | DLT | 20 to 80 GB |

**Figure 7-33** Common types of tapes.

**Web Link**

For more information on tapes, visit the Discovering Computers 2002 Chapter 7 WEB LINK page (**scsite.com/dc2002/ch7/weblink.htm**) and click Tapes.

## *ENTERPRISE STORAGE SYSTEMS*

Many companies use networks. Data, information, and instructions stored on the network must be accessible easily to all authorized users. The data, information, and instructions also must be secure, so unauthorized users do not have access. An **enterprise storage system** is a strategy that focuses on the availability, protection, organization, and backup of storage in a company. The goal of an enterprise storage system is to consolidate storage so operations run as efficiently as possible. Large business users often utilize an enterprise storage system strategy.

To implement an enterprise storage system, a company uses a combination of techniques. As shown in Figure 7-34, an enterprise storage system may use servers, a RAID system, a tape library, CD-ROM jukeboxes, Internet backup, NAS devices, and/or a storage area network. The following paragraphs briefly discuss each of these storage techniques.

- A server stores data, information, and instructions needed by users on the network.
- A RAID system ensures that data is not lost if one drive fails.
- A **tape library** is a high-capacity tape system that works with multiple tape cartridges for storing backups of data, information, and instructions.
- A CD-ROM server, also called a **CD-ROM jukebox**, holds hundreds of CD-ROMs that can contain application programs and data.
- Companies using **Internet backup** store data, information, and instructions on the Web.
- A **network-attached storage** (**NAS**) device is an easy way to add additional hard disk space to the network.
- A **storage area network** (**SAN**) is a high-speed network that connects storage devices.

Some companies manage an enterprise storage system in house. Other larger applications elect to offload all (or at least the backup) storage management to an outside

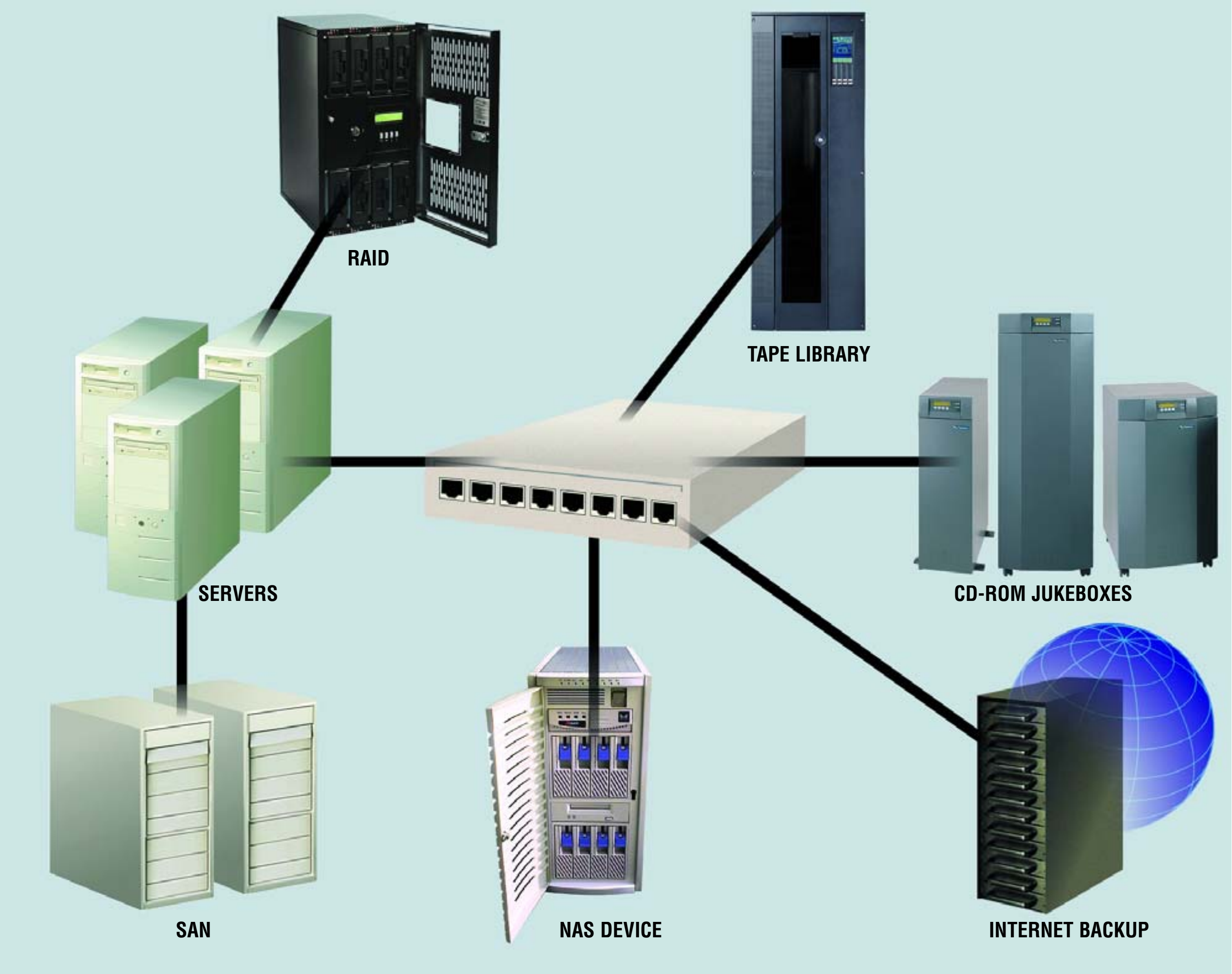


**Figure 7-34** An enterprise storage system uses a variety of storage techniques.

organization or online Web service. Some vendors focus on providing enterprise storage systems to clients. A data warehouse might seek this type of outside service. A **data warehouse** is a huge database system that stores and manages historical and current transaction data. For example, a credit card company that stores and manages millions of customer transactions probably uses a data warehouse.

## PC CARDS

As discussed in Chapter 4, a **PC Card** is a thin, credit card-sized device that fits into a PC Card slot on a notebook or other personal computer. Different types and sizes of PC Cards add storage, additional memory, communications, and sound capabilities to a computer. Notebook computers and other mobile computers and devices most often use PC Cards (Figure 7-35).

Originally called PCMCIA cards, three kinds of PC Cards are available: Type I, Type II, and Type III (Figure 7-36). The only difference in size among the three types is their thickness. Some digital cameras use a Type II or Type III PC Card to store photographs. Type III cards can house a hard disk. The advantage of a PC Card for storage is portability. You easily can transport large amounts of data, instructions, and information from one machine to another using a Type II or Type III PC Card.

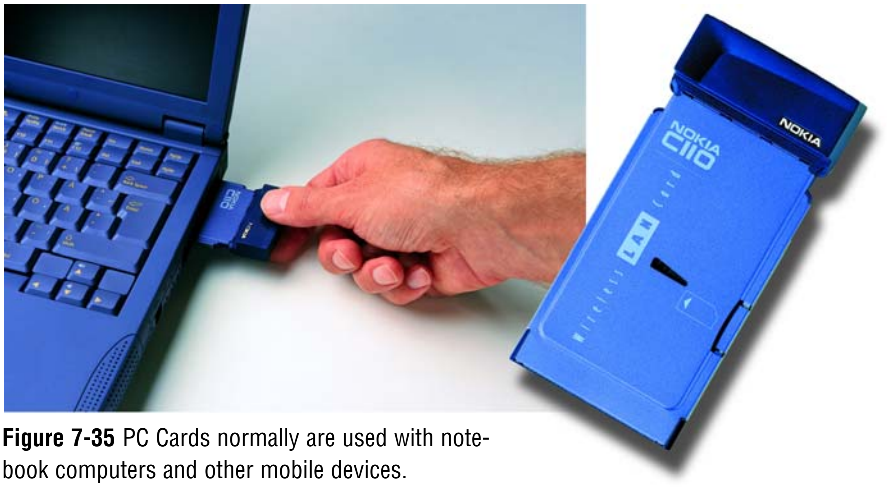


**Figure 7-35** PC Cards normally are used with notebook computers and other mobile devices.

**PC CARDS**

| Category | Thickness | Use |
|---|---|---|
| Type I | 3.3 mm | RAM, SRAM, flash memory |
| Type II | 5.0 mm | Modem, LAN, SCSI, sound, TV tuner, storage |
| Type III | 10.5 mm | Rotating storage such as a hard disk |

**Figure 7-36** The above table outlines the various uses of PC Cards.

## MINIATURE MOBILE STORAGE MEDIA

Handheld computers and digital cameras are wonderful devices that provide the mobile user with immediate access to technology. These handheld devices do not have much internal storage. Some use PC Cards. As shown in the table in Figure 7-37, other types of miniature storage media also are available.

**SOME COMMONLY USED MINIATURE STORAGE MEDIA**

| Device Name | Storage Capacity | Type, Use |
|---|---|---|
| Clik! Disk<br> | 40 MB | Cartridge<br>Digital cameras, notebook computers |
| CompactFlash<br> | 2 to 256 MB | Memory Card<br>Digital cameras, handheld computers, notebook computers, printers, cellular telephones |
| Microdrive<br> | 1 GB | Memory Card<br>Digital cameras, handheld computers, music players, video cameras |
| SmartMedia<br> | 2 to 128 MB | Memory Card<br>Digital cameras, handheld computers, photo printers, cellular telephones |

**Figure 7-37** Miniature storage used with digital cameras and other handheld devices.

To view images and other information captured on a miniature mobile medium, you can transfer its contents to your desktop computer or other device. Some printers read PC cards and other miniature storage media. Handheld devices, such as players and wallets, read or display the contents of miniature storage media such as memory cards (Figure 7-38).

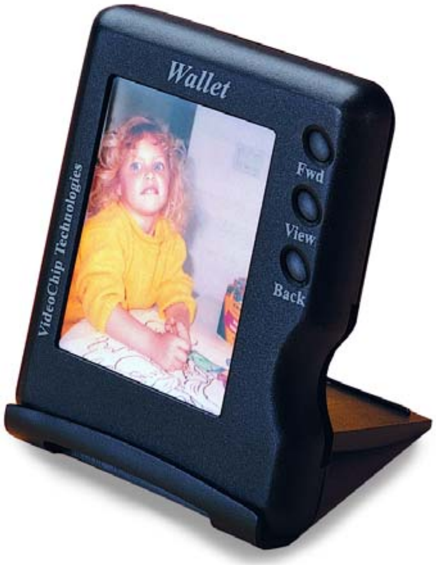


**Figure 7-38** This wallet displays the contents of a memory card.

### *Smart Cards*

A **smart card**, which is similar in size to a credit card or ATM card, stores data on a thin microprocessor embedded in the card (Figure 7-39). When you insert the smart card into a specialized card reader, the information on the smart card is read and, if necessary, updated.

Two types of smart cards exist: intelligent and memory. An **intelligent smart card** contains a processor and has input, process, output, and storage capabilities. A **memory card**, by contrast, has only storage capabilities. A memory card can store a variety of data and information including photographs, music, books, and video clips. As shown earlier, many digital cameras and other handheld devices use memory cards.

One popular use of smart cards is to store a prepaid dollar amount, as in a prepaid telephone calling card. You receive the card with a specific dollar amount stored in the microprocessor. Each time you use the card, it reduces the available amount of money. Using these cards provides convenience to the caller, eliminates the telephone company's need to collect coins from telephones, and reduces vandalism of pay telephones. Other uses of smart cards include storing patient records, vaccination data, and other healthcare information; tracking information such as customer purchases or employee attendance; and storing a prepaid amount such as electronic money.

**Electronic money (e-money)**, also called **digital cash**, is a means of paying for goods and services over the Internet. As discussed in Chapter 2, a bank issues unique digital cash numbers that represent an amount of money. When you purchase digital cash, the amount of money is withdrawn from your bank account. One implementation of e-money places the digital cash on a smart card. To use the card, you swipe it through a card reader on your computer or one that is attached to your computer.

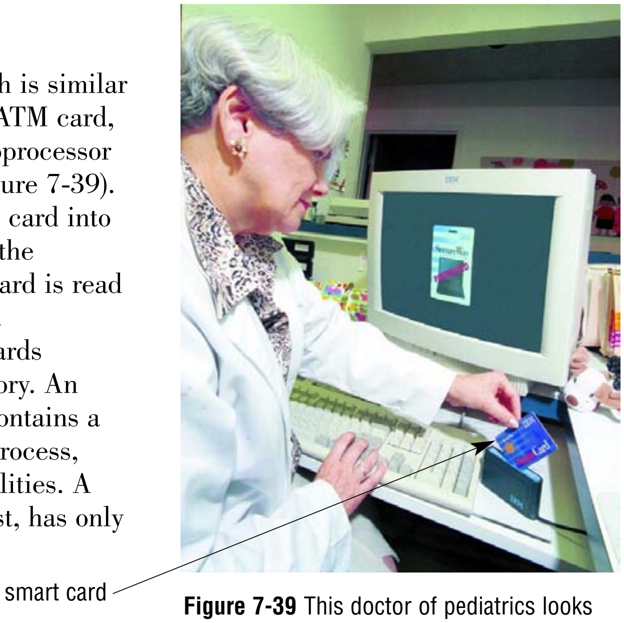


**Figure 7-39** This doctor of pediatrics looks up the confidential patient records on her computer by sliding the smart card through a smart card reader. The smart card reader attaches to the serial port on the computer.

ISSUE

## Will Money Become Obsolete?

### E-Money Society

The first e-commerce transaction from one personal computer to another computer occurred in May 1994. When you conduct a business activity online, you are participating in e-commerce. One method of paying for the goods or services purchased online is e-money. Digital signatures and encryption techniques make e-money possible. This technology is recognized widely by banks as the most secure measure for protecting financial information. Financial institutions tout the many benefits of e-money for the consumer. Some of these include convenient and easy one-button payment, easy refunds, shop online without a credit card, privacy protection, and wireless access. With all of these benefits of e-money, will paper money disappear? Is e-money just a step on the way to tomorrow's payment system technology or is it already here? Would you feel comfortable using e-money? Will society in general accept this technology?

For more information on e-money, visit the Discovering Computers 2002 Issues Web page (**scsite.com/dc2002/issues.htm**) and click Chapter 7 Issue #4.

**Web Link**

For more information on PC Cards, visit the Discovering Computers 2002 Chapter 7 WEB LINK page (**scsite.com/dc2002/ch7/weblink.htm**) and click PC Cards.

## MICROFILM AND MICROFICHE

Microfilm and microfiche store microscopic images of documents on roll or sheet film (Figure 7-40). **Microfilm** uses a 100- to 215-foot roll of film. **Microfiche** uses a small sheet of film, usually about four inches by six inches. A **computer output microfilm** (**COM**) **recorder** is the device that records the images on the film. The stored images are so small that you only can read them with a microfilm or microfiche reader.

Applications of microfilm and microfiche are widespread. Libraries use these media to store back issues of newspapers, magazines, and genealogy records. Large organizations use microfilm and microfiche to archive inactive files. Banks use it to store transactions and cancelled checks. The U.S. Army uses it to store personnel records.

Using microfilm and microfiche provides a number of advantages. It greatly reduces the amount of paper firms must handle. It is inexpensive, and it has the longest life of any storage medium (Figure 7-41).

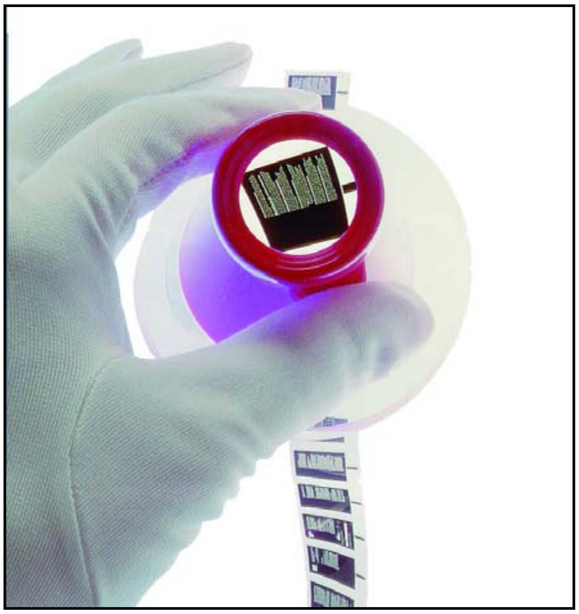


**Figure 7-40** Microfilm and microfiche store microscopic images of documents on roll or sheet film.

**MEDIA LIFE EXPECTANCIES**

| Media Type | Guaranteed Life Expectancy | Potential Life Expectancy |
|---|---|---|
| Tape | 2 to 5 years | 20 years |
| Compact Disc | 5 years | 50 to 100 years |
| Microfilm | 100 years | 200 years |

**Figure 7-41** Microfilm is the medium with the longest life.

ISSUE

### Nothing Lasts Forever

#### Digital Information Deterioration

This aphorism is true even with respect to computer storage. The industry has just begun to realize the magnitude of digital information deterioration. NASA discovered almost 20 percent of the data collected during the Viking mission was lost on decaying magnetic tape. Veterans' files, census statistics, and toxic-waste records also have been lost on deteriorating storage media. One computer scientist admits that digital information lasts forever or five years — whichever comes first. A major problem with digital data is that, unlike the visible deterioration in a faded document, the extent of decay on a storage medium such as a CD-ROM may be invisible until it is too late. If you were the leader of an information-intensive organization, what medium would you choose to store your records? Why? What steps would you take to ensure the records were intact 10 years from now? Twenty years from now?

For more information on digital storage, visit the Discovering Computers 2002 Issues Web page (**scsite.com/dc2002/issues.htm**) and click Chapter 7 Issue #5.

## PUTTING IT ALL TOGETHER

Many factors influence the type of storage devices you should use: the amount of data, instructions, and information to be stored; the hardware and software in use; and the desired cost. The table in Figure 7-42 outlines several suggested storage devices for various types of computer users.

## CHAPTER SUMMARY

Storage refers to the media on which data, instructions, and information are kept, as well as the devices that record and retrieve these items. This chapter explained various storage media and storage devices. Storage media covered included floppy disks, high-capacity disks, hard disks, CD-ROMs, CD-RWs, DVD-ROMs, tape, and PC Cards and other miniature forms of storage. Enterprise storage systems also were covered.

| USER | STORAGE DEVICE |
|---|---|
| **Home** | • 3.5-inch HD floppy disk drive<br>• 250 MB Zip® drive<br>• 30 GB hard disk<br>• Internet hard drive<br>• DVD-ROM drive<br>• CD-RW drive |
| **Small Office/Home Office** | • 3.5-inch HD floppy disk drive<br>• 40 GB hard disk<br>• Internet hard drive<br>• DVD-ROM drive<br>• CD-RW drive<br>• 2 GB Jaz® drive |
| **Mobile** | • 3.5-inch HD floppy disk drive<br>• 1 GB PC Card hard disk<br>• 10 GB hard disk<br>• Internet hard drive<br>• DVD-ROM drive *or* 40X CD-ROM drive |
| **Large Business** | • 3.5-inch HD floppy disk drive<br>• 75 GB hard disk<br>• DVD-ROM drive<br>• CD-RW drive<br>• Microfilm or microfiche<br>• Smart card reader<br>• RAID<br>• Tape drive<br>• Enterprise storage system |
| **Power** | • 3.5-inch HD floppy disk drive<br>• DVD-ROM drive<br>• CD-RW drive<br>• 75 GB hard disk<br>• Internet hard drive<br>• 2 GB Jaz® drive |

**Figure 7-42** This table recommends suggested storage devices.

## Computer Technician

Computer technicians are in great demand in every organization and industry. For many, this is the entry point for a career in the computer/information technology field. The responsibilities of a computer technician or a computer service technician can include a variety of duties. Most companies who employ someone with this title expect the technician to have basic across-the-board knowledge of concepts in the computer electronics field. Some of these tasks are hardware repair and installation; software installation, upgrade, and configuration; and troubleshooting client and/or server problems.

Technicians generally work with a variety of users, so people skills are an important asset, especially the ability to work with groups of non-technical users. Because this is an entry-level position, salaries are not quite as high as other more demanding and skilled positions. Individuals with these skills can expect an average annual starting salary of around $25,000 to $35,000.

The Electronics Technicians Association (see URL below) provides a Computer Service Technician (CST) certification program.

To learn more about the field of computer technician as a career and the Web site mentioned above, visit the Discovering Computers 2002 Careers Web page (**scsite.com/dc2002/careers.htm**) and click Computer Technician.

# E-SHOPPING

## CYBERMALL MANIA

### Let Your Mouse Do Your Shopping

From groceries to clothing to computers, you can buy just about everything you need with just a few clicks of your mouse. Electronic retailers (e-tailers), especially those listed in Figure 7-43, are cashing in from cybershoppers' purchases with books, computer software and hardware, and music being the hottest commodities. Online sales in the United States exceed $60 billion yearly. E-shoppers can browse for a variety of goods at these popular Web sites.

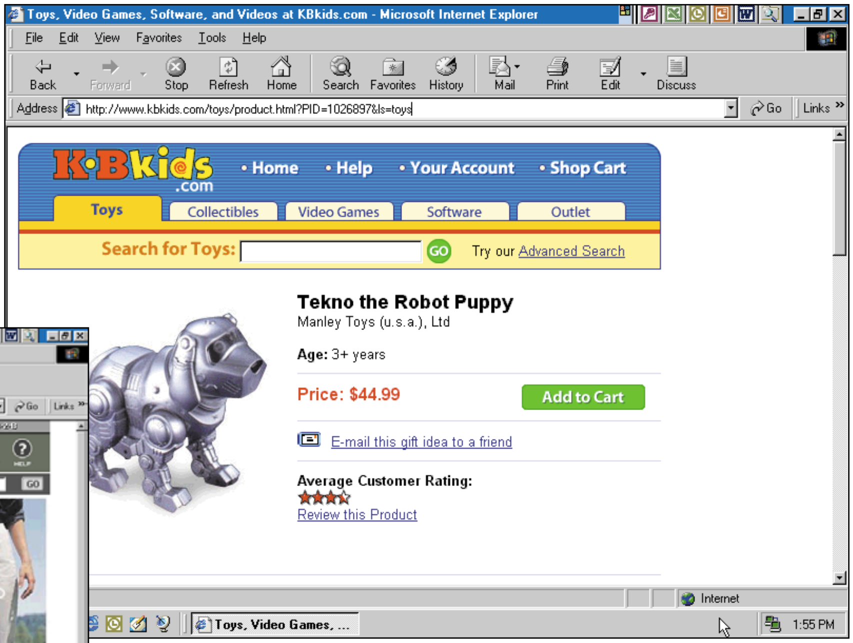
Holiday sales account for a large portion of Internet purchases with nearly nine million households doing some of their holiday shopping online. During the holiday season, some Web sites such as KBkids.com (Figure 7-44) have more than 235,000 hits per day. Macy's, Bloomingdale's, and other e-tailers ship more than 300,000 boxes daily out of warehouses that are the size of 20 football fields and are stocked with five million items.

The two categories of Internet shopping Web sites are those with physical counterparts, such as Eddie Bauer (Figure 7-45),

| SHOPPING WEB SITES | URL |
|---|---|
| **Apparel** | |
| Eddie Bauer | eddiebauer.com |
| J. Crew | jcrew.com |
| Lands' End | landsend.com |
| **Books and Music** | |
| Amazon.com | amazon.com |
| Barnes & Noble | barnesandnoble.com |
| Borders | borders.com |
| **Computers and Electronics** | |
| Crutchfield | crutchfield.com |
| Best Buy | bestbuy.com |
| Buy.com | buy.com |
| **Miscellaneous** | |
| 1-800-Flowers.com | 1800flowers.com |
| drugstore.com | drugstore.com |
| Toys "R" Us | toysrus.com |
| Wal-Mart | walmart.com |

*For an updated list of shopping Web sites, visit scsite.com/dc2002/e-rev.htm.*

**Figure 7-43** Popular Web shopping sites.


Toys, Video Games, Software, and Videos at KBkids.com - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss
Address http://www.kbkids.com/toys/product.html?PID=1026897&ls=toys
Go Links
K·B kids .com
• Home • Help • Your Account • Shop Cart
Toys Collectibles Video Games Software Outlet
Search for Toys: GO Try our Advanced Search
Add to Cart
E-mail this gift idea to a friend
Review this Product
Internet
Toys, Video Games, ...
1:55 PM

**Tekno the Robot Puppy**
Manley Toys (u.s.a.), Ltd
**Age:** 3+ years
Price: $44.99
**Average Customer Rating:** ★★★★

**Figure 7-44** Shopping for popular toys online eliminates waiting in long lines in stores.

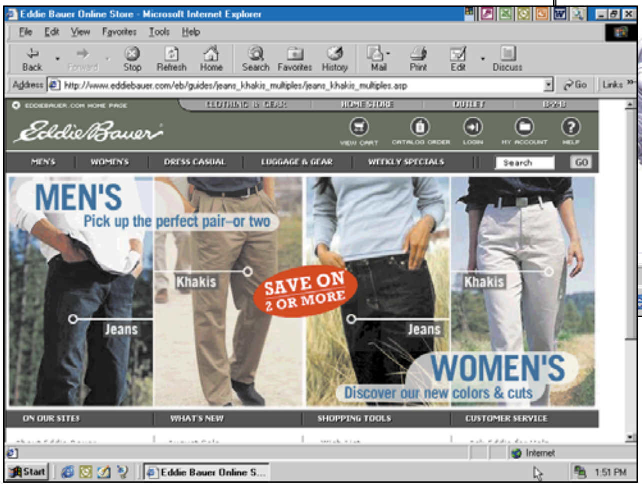

Eddie Bauer Online Store - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss
Eddie Bauer
MEN'S
Pick up the perfect pair–or two
Khakis
Jeans
SAVE ON 2 OR MORE
Khakis
Jeans
WOMEN'S
Discover our new colors & cuts
Internet
Start
Eddie Bauer Online S...
1:51 PM

**Figure 7-45** Stores such as Eddie Bauer have both a physical and an Internet presence.

Wal-Mart, and Nordstrom, and those with only a Web presence, such as Egghead.com (Figure 7-46), and amazon.com.

Some e-shoppers, however, are finding online shopping even more frustrating than finding a convenient parking space at the neighborhood mall on Saturday afternoon. Delayed shipments, out-of-stock merchandise, poor customer service, and difficult return policies have left some savvy shoppers with a poor impression of their Internet experience. As e-tailers rush to set up an Internet site, they sometimes overlook important considerations, such as customer service telephone numbers and e-mail addresses, adequate staff to answer queries quickly and courteously, and sufficient in-stock merchandise.

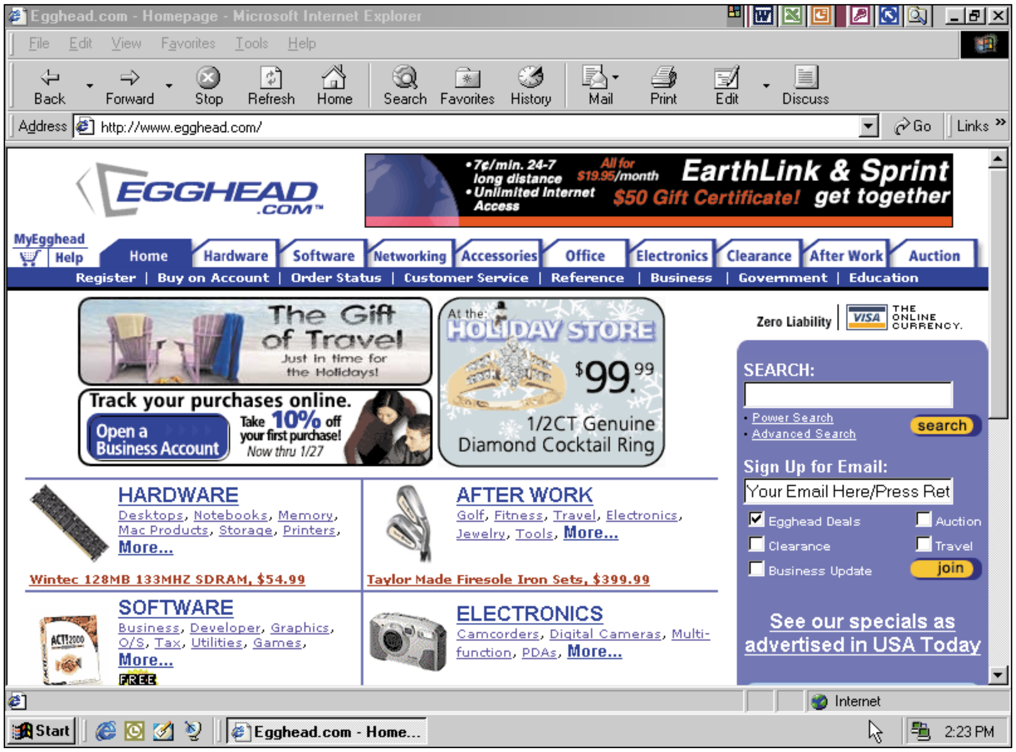

Egghead.com - Homepage - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail Print Edit Discuss
Address http://www.egghead.com/
Go Links
EGGHEAD .COM
EarthLink & Sprint get together
$50 Gift Certificate!
MyEgghead Help
Home Hardware Software Networking Accessories Office Electronics Clearance After Work Auction
Register | Buy on Account | Order Status | Customer Service | Reference | Business | Government | Education
The Gift of Travel
Just in time for the Holidays!
Track your purchases online.
Open a Business Account
Take 10% off your first purchase! Now thru 1/27
At the HOLIDAY STORE
$99.99
1/2CT Genuine Diamond Cocktail Ring
Zero Liability VISA THE ONLINE CURRENCY.
SEARCH:
Power Search
Advanced Search
search
Sign Up for Email:
Your Email Here/Press Ret
☑ Egghead Deals
☐ Auction
☐ Clearance
☐ Travel
☐ Business Update
join
HARDWARE
Desktops, Notebooks, Memory, Mac Products, Storage, Printers, More...
Wintec 128MB 133MHZ SDRAM, $54.99
AFTER WORK
Golf, Fitness, Travel, Electronics, Jewelry, Tools, More...
Taylor Made Firesole Iron Sets, $399.99
SOFTWARE
Business, Developer, Graphics, O/S, Tax, Utilities, Games, More...
FREE
ELECTRONICS
Camcorders, Digital Cameras, Multi-function, PDAs, More...
See our specials as advertised in USA Today
Internet
Start
Egghead.com - Home...
2:23 PM

**Figure 7-46** Egghead.com is a business with only an Internet presence.

Paying for the merchandise online causes concern for many e-shoppers. Although online merchants promise secure transactions, some users are wary of cyberthieves. One way of calming their fears may be through the use of e-money, which is a payment system that allows consumers to purchase goods and services anonymously. Several computer companies, Web merchants, and credit card companies are collaborating to develop a standard method of transferring money securely and quickly from electronic wallets, which verify a user's identity.

For more information on shopping Web sites, visit the Discovering Computers 2002 E-Revolution Web page (scsite.com/dc2002/e-rev.htm) and click Shopping.

## eREVOLUTION E-SHOPPING applied:

1. Visit two of the three apparel Web sites listed in the table in Figure 7-43 and select a specific pair of jeans and a shirt from each one. Create a table with these headings: e-tailer, style, fabric, features, price, tax, and shipping fee. Enter details about your selections in the table. Then, visit two of the books and music Web sites and search for a CD you would consider purchasing. Create another table with the names of the Web site, artist, and CD, as well as the price, tax, and shipping fee.

2. Visit two of the computers and electronics and two of the miscellaneous Web sites listed in Figure 7-43. Write a paragraph describing the features these Web sites offer compared with the same offerings from stores. In another paragraph, describe any disadvantages of shopping at these Web sites instead of actually seeing the merchandise. Then, describe their policies for returning unwanted merchandise and for handling complaints.

# In Summary

**Web Instructions:** To display this page from the Web, start your browser and enter the URL scsite.com/dc2002/ch7/summary.htm. Click the links for current and additional information. To listen to an audio version of this In Summary, click the Audio button. To play the audio, RealPlayer must be installed on your computer (download by clicking here).

## 1

## How Is Storage Different from Memory?

Memory, which is composed of one or more chips on the motherboard, holds data and instructions while they are being interpreted and executed by the processor. Memory can be **volatile** or **nonvolatile**. Storage holds items such as data, instructions, and information for future use.

## 2

## What Are Storage Media and Storage Devices?

A **storage medium** (media is the plural) is the physical material on which items such as data, instructions, and information are kept. A **storage device** is the mechanism used to record and retrieve items to and from a storage medium. When a storage device transfers items from a storage medium into memory — a process called reading — it functions as an input device. When a storage device transfers items from memory to a storage medium — a process called **writing** — it functions as an output device.

## 3

## How Is Data Stored on a Floppy Disk?

A **floppy disk** is a portable, inexpensive storage medium that consists of a thin, circular, flexible disk with a plastic magnetic coating enclosed in a square-shaped plastic shell. Formatting prepares a disk for reading and writing by organizing the disk into storage locations called **tracks** and **sectors**. A **floppy disk drive** (**FDD**) is a device that reads from and writes on a floppy disk. The drive slides the **shutter** to the side to expose a portion of both sides of the floppy disk's recording surface. A circuit board on the drive sends signals to control the movement of the read/write head, which is the mechanism that reads items from or writes items on the floppy disk. A motor causes the floppy disk to spin and positions the read/write head over the correct location on the recording surface. The read/write head then writes data on the floppy disk. Floppy disks should not be exposed to heat, cold, magnetic fields, or contaminants such as dust, smoke, or salt air. The disk's shutter should not be opened and the recording surface should not be touched. Floppy disks should be inserted carefully into the disk drive and kept in a storage tray when not in use.

## 4

## What Are the Advantages of Using High-Capacity Disks?

A disk with capacities of 100 MB or greater is called a high-capacity disk. To store large graphics, audio, video, or other large files and for data **backup**, high-capacity disks are the best choice for storage. Three types of high-capacity disk drives are the **SuperDisk™ drive**, the **HiFD™** (High-Capacity Floppy Disk) **drive**, and the **Zip® drive**.

## 5

## How Does a Hard Disk Organize Data?

A **hard disk** consists of several inflexible, circular disks called platters on which items are stored electronically. A hard disk can be divided into separate areas called **partitions** with each partition functioning as if it were a separate hard disk drive. An **optically-assisted hard drive** combines laser and optic technologies with the magnetic media.

## 6

## What Are the Advantages of Using an Internet Hard Drive?

An **Internet hard drive** is a service on the Web that provides storage to computer users. Many offer this service without charge. Users may store information on an **Internet hard drive** so they can access files from any computer or device that has Web access, download and save large files, share files with others, view time-critical data and images, and store offsite backup of data.

## 7 How Is Data Stored on Compact Discs?

A **compact disc** (**CD**) is a flat, round, portable metal storage medium that usually is 4.75 inches in diameter and less than one-twentieth of an inch thick. Compact discs store items in microscopic pits (indentations) and land (flat areas) that are located in the middle layer, usually under the printed label on the disc. A high-powered laser light creates the pits in a single track, divided into evenly sized sectors, that spirals from the center of the disc to the edge of the disc. A lower-powered laser reads items from the compact disc by reflecting light through the bottom of the disc surface. The reflected light is converted into a series of bits that the computer can process.

## 8 How Do You Care for a Compact Disc?

Compact discs should not be stacked or exposed to heat, cold, and contaminants. The underside should not be touched. A compact disc should be held by its edges and placed in its protective case, called a **jewel box**, when it is not being used. The bottom surface of the compact disc can be cleaned with a soft cloth and warm water or a specialized CD cleaning kit.

## 9 How Are CD-ROMs, CD-RWs, and DVD-ROMs Different?

A **CD-ROM** is a compact disc that uses the same laser technology as audio CDs for recording music. A typical CD-ROM can hold about 650 MB of data, instructions, and information. A **CD-RW** is an erasable disc on which you can write multiple times. These discs can be read only by multiread CD-ROM drives. A **DVD-ROM** is an extremely high capacity compact disc capable of storing from 4.7 GB to 17 GB. Both the storage capacity and quality of a DVD-ROM surpass that of a CD-ROM. A DVD-ROM stores data in a different manner than a CD-ROM, making the disc more dense by packing pits closer together, by using two layers of pits, or by using both sides of the disc. You must have a **DVD-ROM drive** or **DVD player** to read a DVD-ROM disc.

## 10 What Are Some Uses for Tape?

**Tape** is a magnetically coated ribbon of plastic capable of storing large amounts of data and information at a low cost. Tape storage requires sequential access, which refers to reading or writing data consecutively. Tape mainly is used for long-term storage and backup.

## 11 How Does an Enterprise Storage System Work?

An **enterprise storage system** is a strategy that focuses on the availability, protection, organization, and backup of storage in a company. It is implemented using the following techniques: a server for the users, a RAID system, a **storage area network** (**SAN**), a **network-attached storage** (**NAS**) device, a **CD-ROM jukebox**, **Internet backup**, and a **tape library**.

## 12 How Do You Use PC Cards and Other Miniature Storage Media?

A **PC Card** is a thin, credit card-sized device that fits into a PC Card slot on a notebook computer or personal computer. PC Cards are used to add storage, memory, communications, and sound capabilities. A **smart card**, similar in size to an ATM card, stores data on a thin processor embedded in the card. Smart cards are used to store prepaid dollar amounts, such as electronic money; patient records in the health-care industry; and tracking information, such as customer purchases.

## 13 What Are Some Uses for Microfilm and Microfiche?

**Microfilm** and **microfiche** store microscopic images of documents on roll (microfilm) or sheet (microfiche) film. Libraries and large organizations use microfilm and microfiche to archive relatively inactive documents and files.

# Key Terms

**Web Instructions:** To display this page from the Web, start your browser and enter the URL scsite.com/dc2002/ch7/terms.htm. Scroll through the list of terms. Click a term to display its definition and a picture. Click the To WEB button for current and additional information about the term from the Web. To see animations, Shockwave and Flash Player must be installed on your computer (download by clicking here).

access time (7.4)
allocation unit (7.8)
ATA (7.13)
auxiliary storage (7.4)
backup (7.9)
cache controller (7.12)
capacity (7.4)
CD recorder (7.22)
CD-R (compact disc-recordable) (7.22)
CD-R drive (7.22)
CD-ROM (7.20)
CD-ROM drive (7.20)
CD-ROM jukebox (7.27)
CD-ROM player (7.20)
CD-RW (compact disc-rewritable) (7.22)
CD-RW drive (7.22)
cluster (7.8)
compact disc (CD) (7.17)

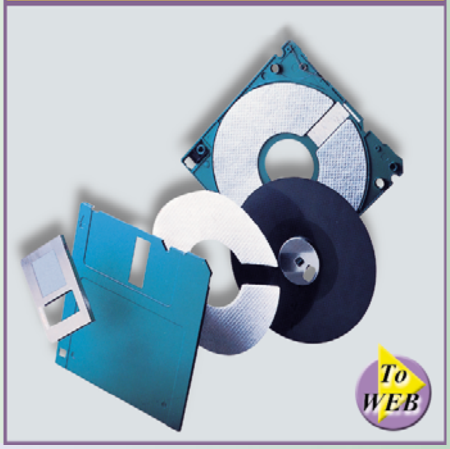
**PhotoCD**

Compact disc that contains only digital photographic images saved in PhotoCD format. PhotoCDs containing pictures can be purchased, or a user can have his or her own pictures or negatives recorded on a PhotoCD in order to have digital versions of photographs. (7.21)

compact disc read-only memory (7.20)
computer output microfilm (COM) recorder (7.30)
cylinder (7.11)
data warehouse (7.28)
density (7.7)
digital cash (7.29)
direct access (7.26)
disk cache (7.12)
disk cartridge (7.13)
disk controller (7.13)
diskette (7.6)
downward compatible (7.7)
DVD player (7.25)
DVD+RW (7.25)
DVD-R (DVD-recordable) (7.25)
DVD-RAM (7.25)
DVD-ROM (digital video disc-ROM) (7.25)
DVD-ROM drive (7.25)
electronic money (e-money) (7.29)
Enhanced Integrated Drive Electronics (EIDE) (7.13)
enterprise storage system (7.27)
erasable CD (CD-E) (7.22)
fixed disk (7.10)
floppy disk (7.6)
floppy disk drive (FDD) (7.6)
formatting (7.8)
hard disk (7.10)
hard disk controller (HDC) ( 7.13)
hard disk drive (7.10)
head crash (7.12)
HiFD™ (High-Capacity Floppy Disk) drive (7.10)
high-capacity disk drive (7.9)
intelligent smart card (7.29)
Internet backup (7.27)
Internet hard drive (7.16)
Jaz® disk (7.13)
jewel box (7.19)
level 1 (7.14)
magnetic media (7.8)
mass storage (7.4)
memory card (7.29)
microfiche (7.30)
microfilm (7.30)
mirroring (7.14)
multiread CD-ROM drive (7.22)
multisession (7.21)
network-attached storage (NAS) (7.27)
nonvolatile memory (7.3)
online storage (7.16)
optical disc (7.17)
optically-assisted hard drive (7.10)
partitions (7.12)
PC Card (7.28)
permanent storage (7.4)
PhotoCD (7.21)
Picture CD (7.21)
platter (7.10)
RAID (redundant array of independent disks) (7.14)

**Floppy Disk**

Portable, inexpensive storage medium that consists of a thin, circular, flexible plastic disk with a magnetic coating. (7.5)



random access (7.26)
reading (7.4)
records (7.20)
removable hard disk (7.13)
secondary storage (7.4)
sectors (7.8)
sequential access (7.26)
shutter (7.6)
single-session (7.21)
small computer system interface (SCSI) (7.13)
smart card (7.29)
storage (7.4)
storage area network (SAN) (7.27)
storage device (7.4)
storage medium (7.4)
striping (7.14)
SuperDisk™ drive (7.10)
tape (7.26)
tape cartridge (7.26)
tape drive (7.26)
tape library (7.27)
track (7.8)
upward compatible (7.7)
volatile memory (7.3)
write-protect notch (7.9)
writing (7.4)
Zip® disk (7.10)
Zip® drive (7.10)

# Learn It Online

**Web Instructions:** To display this page from the Web, start your browser and enter the URL scsite.com/dc2002/ch7/learn.htm.

## 1. Web Guide

Click Web Guide to display the Guide to World Wide Web Sites and Searching Techniques Web page. Click Reference and then click Webopedia. Search for optical disc. Click one of the optical disc links. Use your word processing program to prepare a brief report on your findings and submit your assignment to your instructor.

## 2. Scavenger Hunt

Click Scavenger Hunt. Print a copy of the Scavenger Hunt page; use this page to write down your answers as you search the Web. Submit your completed page to your instructor.

## 3. Who Wants to Be a Computer Genius?

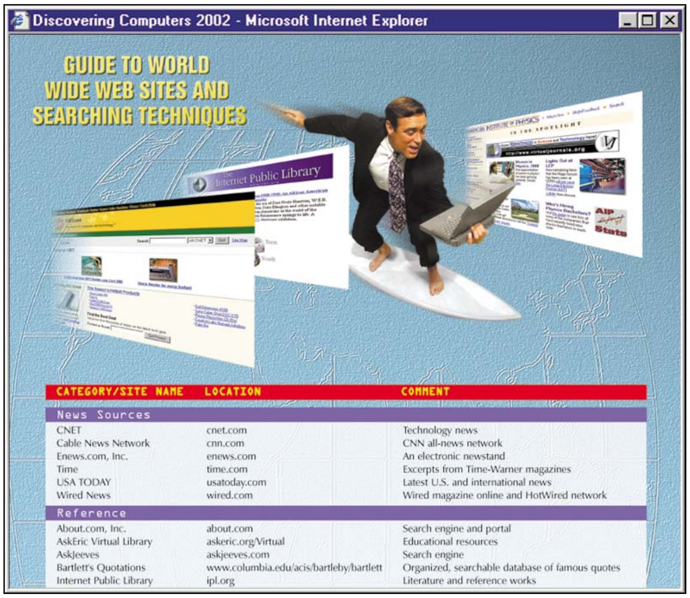
Click Computer Genius to find out if you are a computer genius. Directions on how to play the game will display. When you are ready to play, click the PLAY button. Submit your score to your instructor.

## 4. Wheel of Terms

Click Wheel of Terms to reinforce important terms you learned in this chapter by playing the Shelly Cashman Series version of this popular game. Directions on how to play the game will display. When you are ready to play, click the PLAY button. Submit your score to your instructor.

## 5. Career Corner

Click Career Corner to display the Campus Career page. Click a link of an area of interest and review the information. Write a brief report describing what you discovered. Submit the report to your instructor.


Discovering Computers 2002 - Microsoft Internet Explorer
GUIDE TO WORLD WIDE WEB SITES AND SEARCHING TECHNIQUES
Internet Public Library

| CATEGORY/SITE NAME | LOCATION | COMMENT |
|---|---|---|
| **News Sources** | | |
| CNET | cnet.com | Technology news |
| Cable News Network | cnn.com | CNN all-news network |
| Enews.com, Inc. | enews.com | An electronic newstand |
| Time | time.com | Excerpts from Time-Warner magazines |
| USA TODAY | usatoday.com | Latest U.S. and international news |
| Wired News | wired.com | Wired magazine online and HotWired network |
| **Reference** | | |
| About.com, Inc. | about.com | Search engine and portal |
| AskEric Virtual Library | askeric.org/Virtual | Educational resources |
| AskJeeves | askjeeves.com | Search engine |
| Bartlett's Quotations | www.columbia.edu/acis/bartleby/bartlett | Organized, searchable database of famous quotes |
| Internet Public Library | ipl.org | Literature and reference works |

## 6. Search Sleuth

Click Search Sleuth to learn search techniques that will help make you a research expert. Submit the completed assignment to your instructor.

## 7. Crossword Puzzle Challenge

Click Crossword Puzzle Challenge. Complete the puzzle to reinforce skills you learned in this chapter. Directions on how to play the game will display. When you are ready to play, click the PLAY button. Submit the completed puzzle to your instructor.

## 8. Practice Test

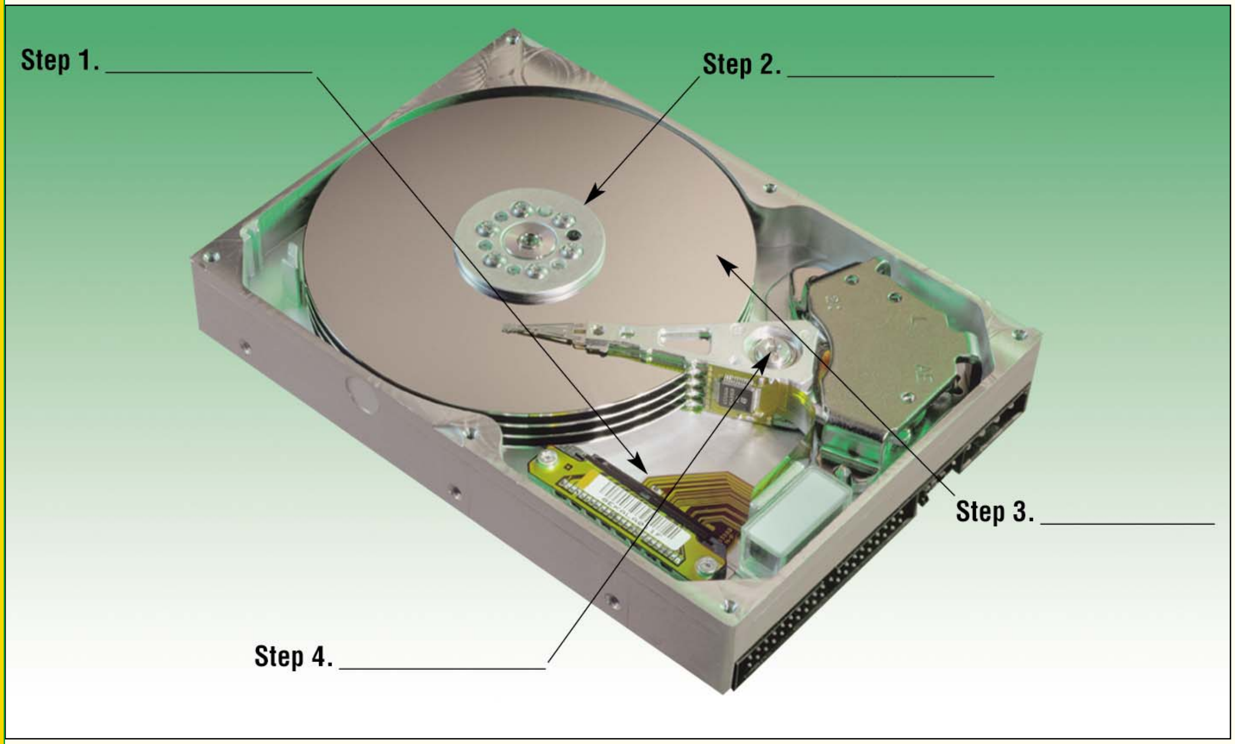
Click Practice Test. Answer each question. When completed, enter your name and click the Grade Test button to submit the quiz for grading. Make a note of any missed questions. If required, print a copy to submit to your instructor.

# Checkpoint

**Web Instructions:** To display this page from the Web, launch your browser and enter the URL scsite.com/dc2002/ch7/check.htm. Click the links for current and additional information. To experience the animation and interactivity, Shockwave and Flash Player must be installed on your computer (download by clicking here.)

## LABEL THE FIGURE

**Instructions:** Identify each step of how a hard disk works.



## MATCHING

**Instructions:** Match each term from the column on the left with the best description from the column on the right.

| | |
|---|---|
| _______ 1. CD-ROM | a. Typically stores data on both sides of the disk, has 80 tracks on each side of the recording surface, and 18 sectors per track. |
| _______ 2. hard disk | b. An erasable optical disc you can write on multiple times. |
| _______ 3. floppy disk | c. A silver-colored compact disc that uses the same laser technology as audio CDs. |
| _______ 4. Zip® disk | d. Consists of several inflexible, circular platters that store items electronically. |
| _______ 5. CD-RW | e. A drive that can read audio CDs, data CD-ROMs, CD-Rs, and CD-RWs. |
| | f. Slightly larger than and about twice as thick as a 3.5-inch floppy disk, and can store 100 MB or 250 MB of data. |
| | g. A multisession compact disc onto which you can record your own items such as text, graphics, and audio. |

## MULTIPLE CHOICE

**Instructions:** Select the letter of the correct answer for each of the following questions.

1. Secondary storage is ___________ .
   a. volatile
   b. nonvolatile
   c. permanent
   d. both b and c
2. The amount of time it takes the device to locate an item on a disk is called ___________ .
   a. reading time
   b. writing time
   c. access time
   d. locating time
3. Most ___________ have multiple platters stacked on top of one another.
   a. hard disks
   b. floppy disks
   c. CD-ROMs
   d. Zip® disks
4. An Internet hard drive is a service on the Web that provides ___________ to computer users.
   a. a multiread CD-ROM drive
   b. a CD-ROM jukebox
   c. online storage
   d. sectors
5. A ___________ is an extremely high-capacity compact disc capable of storing from 4.7 GB to 17 GB.
   a. CD-RW
   b. DVD-ROM
   c. CD-R
   d. PhotoCD

## SHORT ANSWER

**Instructions:** Write a brief answer to each of the following questions.

1. What is access time? ___________ Why is hard disk access time faster than floppy disk access time? ___________
2. What is disk density? ___________ What does it mean to say that floppy disk drives are downward compatible but not upward compatible? ___________
3. What is a head crash? ___________ How does a disk cache improve hard disk access time? ___________
4. How does an Internet hard drive work? ___________ Why would someone want to use one of these? ___________ What disadvantages could there be? ___________
5. How are multisession CD-ROMs different from single-session CD-ROMs? ___________ What are the four basic formats of compact discs? ___________ How are CD-Rs and CD-RWs different? ___________

## WORKING TOGETHER

**Instructions:** Working with a group of your classmates, complete the following team exercise.

Data and information backup is as important for people with personal computers as it is for companies. Develop a report detailing what your group would consider to be the ideal backup system and devices for the following scenarios: (1) a home computer for personal use; (2) a computer used in a home-based business; (3) a small business with six to eight computers; (4) a business or organization with up to 100 computers; and (5) a business or organization with more than 100 computers. Include information that supports why you selected the particular options. Develop a PowerPoint presentation and present your information to the class.

# In The Lab

**Web Instructions:** To display this page from the Web, start your browser and enter the URL scsite.com/dc2002/ch7/lab.htm. Click the links for current and additional information.

## Examining My Computer

1.

How many disk drives does your computer have? What letter is used for each? To find out more about the disk drives on your computer, right-click the My Computer icon on the desktop. Click Open on the shortcut menu. What is the drive letter for the floppy disk drive on your computer? What letter(s) are used for the hard disk drives on your computer? If you have a CD-ROM drive, what letter is used for it? Double-click the Hard disk (C:) drive icon in the My Computer window. The Hard disk (C:) window shows the file folders (yellow folder icons) stored on your hard disk. How many folders are on the hard disk? Click the Close button to close the Hard disk (C:) window. Close the My Computer window.

## Working with Files

2.

Insert the Discover Data Disk into drive A. See the inside back cover of this book for instructions for downloading the Data Disk or see your instructor for information on accessing the files required in this book. Double-click the My Computer icon on the desktop. When the My Computer window opens, right-click the 3½ Floppy (A:) icon. Click Open on the shortcut menu. Click View on the menu bar and then click Large Icons. Right-click the h3-2 icon. If h3-2 is not on the floppy disk, ask your instructor for a copy. Click Copy on the shortcut menu. Click Edit on the menu bar and then click Paste. How has the 3½ Floppy (A:) window changed? Right-click the new icon (Copy of h3-2) and then click Rename on the shortcut menu. Type `h7-2` and then press the ENTER key. Right-click the h7-2 icon and then click Print on the shortcut menu. Close the 3½ Floppy (A:) window. Close the My Computer window.

## Learning About Your Hard Disk

3.

What are the characteristics of your hard disk? To find out, right-click the My Computer icon on the desktop. Click Open on the shortcut menu. Right-click the Hard disk (C:) icon in the My Computer window. Click Properties on the shortcut menu. If necessary, click the General tab and then answer the following questions:

- What Label is on the disk?
- What Type of disk is it?
- How much of the hard disk is Used space?
- How much of the hard disk is Free space?
- What is the total Capacity of the hard disk?

Close the Hard disk (C:) Properties dialog box and the My Computer window.

## Disk Cleanup

4.

This exercise uses Windows 2000 procedures. Just as people maintain they never can have too much money, computer users insist that you never can have too much hard disk space. Fortunately, Windows includes a utility program called Disk Cleanup that can increase available hard disk space. To find out more about Disk Cleanup, click the Start button on the taskbar and then click Help on the Start menu. Click the Index tab in the Windows 2000 window and then type `disk cleanup` in the Type in the keyword to find text box. Click the overview subentry below the Disk Cleanup entry in the list of topics and then click the Display button. Read the Help information in the right pane of the Windows 2000 window and answer the following questions:

- How does Disk Cleanup help to free up space on the hard disk?
- How do you start Disk Cleanup using the Start button?

Click the Close button to close the Windows 2000 window.

# Web Work

**Web Instructions:** To display this page from the Web, start your browser and enter the URL scsite.com/dc2002/ch7/web.htm. To view At The Movies in exercise 1, RealPlayer must be installed on your computer (download by clicking here). To use the Shelly Cashman Series Maintaining Your Hard Drive Lab from the Web, Shockwave and Flash Player must be installed on your computer (download by clicking here).

## Pocket Card

To view the Pocket Card movie, click the button to the left or click the Play button to the right. Watch the movie, and then complete the exercise by answering the questions below. The dangers of too-easy credit are all too obvious, and often personally painful. Addressing these dangers, the pocket card (actually a debit card) was developed to provide access to a fixed-dollar limit, corresponding to a pre-deposited amount. In emergencies (or perhaps with a heartrending story to one's parent) it is possible to increase the amount with a deposit or transfer, either online or using a Touch-Tone telephone. Pocket cards also offer monitoring and accountability, because purchases trigger e-mail notification to the card's owner. The budgeting and monitoring features have attracted two prime markets: parents of out-of-town students, and employers of salespeople. Why these two markets? What other target opportunities can you see?

## Shelly Cashman Series Maintaining Your Hard Drive Lab

Follow the appropriate instructions in Web Work 2 on page 1.47 to start and use the Shelly Cashman Series Maintaining Your Hard Drive Lab. If you are running from the Web, enter the URL, www.scsite.com/sclabs/menu.htm; or display the Web Work page (see instructions at the top of this page) and then click the button to the left.

## Digital Video Disc (DVD)

A DVD can hold almost 25 times more data than a CD. This translates into richer sound and images than ever seen or heard before. The quality of DVD storage is beginning to have a major impact on the market. Some expect that the sales of DVD optical drives soon will pass the $4 billion mark. Click the button to the left and complete this exercise to learn more about DVDs.

## Personal Information Management

Are you tired of forgetting birthdays, missing meetings, overlooking appointments, or neglecting to complete important tasks? If so, then personal information management software may be perfect for you. Click the button to the left to find out about a free, Internet-based calendar. How could this calendar help you organize your life? How might the calendar help you have more fun? After reading the information, you may sign up to create your own Internet-based calendar.

## In the News

IBM recently unveiled a small disk drive, about the size of a quarter, that is capable of storing 1 GB of information, as much as 690 floppy disks. The drive will be used in devices such as digital cameras. What other storage devices are on the horizon? Click the button to the left and read a news article about a new or improved storage device. What is the device? Who manufactures it? How is the storage device better than, or different from, earlier devices? How will the device be used? Why?